SCIENCE

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*AN UNDISCOVERED GAS.**

A sectional address to members of the British Association falls under one of three heads. It may be historical, or actual, or prophetic; it may refer to the past, the present or the future. In many cases, indeed in all, this classification overlaps. Your former presidents have given sometimes a historical introduction, followed by an account of the actual state of some branch of our science, and, though rarely, concluding with prophetic remarks. To those who have an affection for the past, the historical side appeals forcibly; to the practical man, and to the investigator engaged in research, the actual, perhaps, presents more charm; while to the general public, to whom novelty is often more of an attraction than truth, the prophetic aspect excites most interest. In this address I must endeavor to tickle all palates; and perhaps I may be excused if I take this opportunity of indulging in the dangerous luxury of prophecy, a luxury which the managers of scientific journals do not often permit their readers to taste.

The subject of my remarks to-day is a new gas. I shall describe to you later its curious properties; but it would be unfair not to put you at once in possession of the knowledge of its most remarkable property —it has not yet been discovered. As it is still unborn, it has not yet been named. The naming of a new element is no easy matter. For there are only twenty-six letters in our alphabet, and there are already over seventy elements. To select a name expressible by a symbol which has not al-

* Address to the Chemical Section, British Association for the Advancement of Science, Toronto, 1897, by the President of the Section.

ready been claimed for one of the known elements is difficult, and the difficulty is enhanced when it is at the same time required to select a name which shall be descriptive of the properties (or want of properties) of the element.

It is now my task to bring before you the evidence for the existence of this undiscovered element.

It was noticed by Döbereiner, as long ago as 1817, that certain elements could be arranged in groups of three. The choice of the elements selected to form these triads was made on account of their analogous properties, and on the sequence of their atomic weights, which had at that time only recently been discovered. Thus calcium, strontium and barium formed such a group; their oxides, lime, strontia and baryta are all easily slaked, combining with water to form soluble lime-water, strontia-water and baryta-water. Their sulphates are all sparingly soluble and resemblance had been noticed between their respective chlorides and between their nitrates. Regularity was also displayed by their atomic weights. The numbers then accepted were 20, 42.5 and 65; and the atomic weight of strontium, 42.5, is the arithmetical mean of those of the other two elements, for $(65+20)/2 = 42.5$. The existence of other similar groups of three was pointed out by Döbereiner, and such groups became known as 'Döbereiner's triads.'

Another method of classifying the elements, also depending on their atomic weights, was suggested by Pettenkofer, and afterwards elaborated by Kremers, Gladstone and Cooke. It consisted in seeking for some expression which would represent the differences between the atomic weights of certain allied elements. Thus, the difference between the atomic weight of lithium, 7, and sodium, 23, is 16; and between that of sodium and of potassium, 39, is also 16. The regularity is not always so conspicuous; Dumas, in 1857, contrived a somewhat complicated expression, which, to some extent, exhibited regularity in the atomic weights of fluorine, chlorine, bromine, and iodine, and also of nitrogen, phosphorus, arsenic, antimony and bismuth.

The upshot of these efforts to discover regularity was that, in 1864, Mr. John Newlands, having arranged the elements in eight groups, found that when placed in the order of their atomic weights, 'the eighth element, starting from a given one, is a kind of repetition of the first, like the eighth note of an octavo in music.' To this regularity he gave the name 'The Law of Octaves.'

The development of this idea, as all chemists know, was due to the late Professor Lothar Meyer, of Tübingen, and to Professor Mendeléeff, of St. Petersburg. It is generally known as the 'Periodic Law.' One of the simplest methods of showing this arrangement is by means of a cylinder divided into eight segments by lines drawn parallel to its axis; a spiral line is then traced round the cylinder, which will, of course, be cut by these lines eight times at each revolution. Holding the cylinder vertically, the name and atomic weight of an element is written at each intersection of the spiral with a vertical line, following the numerical order of the atomic weights. It will be found, according to Lothar Meyer and Mendeléeff, that the elements grouped down each of the vertical lines form a natural class; they possess similar properties, form similar compounds, and exhibit a graded relationship between their densities, melting points, and many of their other properties. One of these vertical columns, however, differs from the others, inasmuch as on it there are three groups, each consisting of three elements with approximately equal atomic weights. The elements in question are iron, cobalt and nickel; palladium, rhodium and ruthenium; and platinum,

iridium and osmium. There is apparently room for a fourth group of three elements in this column, and it may be a fifth. And the discovery of such a group is not unlikely, for when this table was first drawn up Professor Mendeléeff drew attention to certain gaps, which have since been filled up by the discovery of gallium, germanium and others.

The discovery of argon at once raised the curiosity of Lord Rayleigh and myself as to its position in this table. With a density of nearly 20, if a diatomic gas, like oxygen and nitrogen, it would follow fluorine in the periodic table; and our first idea was that argon was probably a mixture of three gases, all of which possessed nearly the same atomic weights, like iron, cobalt and nickel. Indeed, their names were suggested, on this supposition, with patriotic bias, as Anglium, Scotium and Hibernium! But when the ratio of its specific heats had, at least in our opinion, unmistakably shown that it was molecularly monatomic, and not diatomic, as at first conjectured, it was necessary to believe that its atomic weight was 40, and not twenty, and that it followed chlorine in the atomic table and not fluorine. But here arises a difficulty. The atomic weight of chlorine is 35.5, and that of potassium, the next element in order in the table, is 39.1; and that of argon, 40, follows, and does not precede, that of potassium, as it might be expected to do. It still remains possible that argon, instead of consisting wholly of monatomic molecules, may contain a small percentage of diatomic molecules; but the evidence in favor of this supposition is, in my opinion, far from strong. Another possibility is that argon, as at first conjectured, may consist of a mixture of more than one element; but, unless the atomic weight of one of the elements in the supposed mixture is very high, say 82, the case is not bettered, for one of the elements in the supposed trio would still have a higher atomic weight than potassium. And very careful experiments, carried out by Dr. Norman Collie and myself, on the fractional diffusion of argon, have disproved the existence of any such element with high atomic weight in argon, and, indeed, have practically demonstrated that argon is a simple substance and not a mixture.

The discovery of helium has thrown a new light on this subject. Helium, it will be remembered, is evolved on heating certain minerals, notably those containing uranium; although it appears to be contained in others in which uranium is not present, except in traces. Among these minerals are clèveite, monazite, fergusonite, and a host of similar complex mixtures, all containing rare elements, such as niobium, tantalum, yttrium, cerium, etc. The spectrum of helium is characterized by a remarkably brilliant yellow line, which had been observed as long ago as 1868 by Professors Frankland and Lockyer in the spectrum of the sun's chromosphere, and named 'helium' at that early date.

The density of helium proved to be very close to 2.0, and, like argon, the ratio of its specific heat showed that it, too, was a monatomic gas. Its atomic weight, therefore, is identical with its molecular weight, viz., 4.0, and its place in the periodic table is between hydrogen and lithium, the atomic weight of which is 7.0.

The difference between the atomic weights of helium and argon is thus 36, or 40 — 4. Now there are several cases of such a difference. For instance, in the group the first member of which is fluorine we have:

Fluorine........................	19	
		16.5
Chlorine........................	35.5	
		19.5
Manganese........................	55	

In the oxygen group—

Oxygen........................	16	
		16
Sulphur........................	32	
		20.3
Chromium........................	52.3	

In the nitrogen group—

Nitrogen	14	
		17
Phosphorus	31	
		20.4
Vanadium	51.4	

And in the carbon group—

Carbon	12	
		16.3
Silicon	28.3	
		19.8
Titanium	48.1	

These instances suffice to show that approximately the differences are 16 and 20 between consecutive members of the corresponding groups of elements. The total differences between the extreme members of the short series mentioned are—

Manganese—Fluorine	36
Chromium—Oxygen	36.3
Vanadium—Nitrogen	37.4
Titanium—Carbon	36.1

This is approximately the difference between the atomic weights of helium and argon, 36.

There should, therefore, be an undiscovered element between helium and argon, with an atomic weight 16 units higher than that of helium, and 20 units lower than that of argon, namely 20. And if this unknown element, like helium and argon, should prove to consist of monatomic molecules, then its density should be half its atomic weight, 10. And pushing the analogy still farther, it is to be expected that this element should be as indifferent to union with other elements as the two allied elements.

My assistant, Mr. Morris Travers, has indefatigably aided me in a search for this unknown gas. There is a proverb about looking for a needle in a haystack; modern science, with the aid of suitable magnetic appliances, would, if the reward were sufficient, make short work of that proverbial needle. But here is a supposed unknown gas, endowed, no doubt, with negative properties and the whole world to find it in. Still, the attempt had to be made.

We first directed our attention to the sources of helium—minerals. Almost every mineral which we could obtain was heated in a vacuum, and the gas which was evolved examined. The results are interesting. Most minerals give off gas when heated, and the gas contains, as a rule, a considerable amount of hydrogen, mixed with carbonic acid, questionable traces of nitrogen, and carbonic oxide. Many of the minerals, in addition, gave helium, which proved to be widely distributed, though only in minute proportion. One mineral—malacone—gave appreciable quantities of argon; and it is noteworthy that argon was not found except in it (and, curiously, in much larger amount than helium), and in a specimen of meteoric iron. Other specimens of meteoric iron were examined, but were found to contain mainly hydrogen, with no trace of either argon or helium. It is probable that the sources of meteorites might be traced in this manner, and that each could be relegated to its particular swarm.

Among the minerals examined was one to which our attention had been directed by Professor Lockyer, named eliasite, from which he said that he had extracted a gas in which he had observed spectrum lines foreign to helium. He was kind enough to furnish us with a specimen of this mineral, which is exceedingly rare, but the sample which we tested contained nothing but undoubted helium.

During a trip to Iceland, in 1895, I collected some gas from the boiling springs there; it consisted, for the most part, of air, but contained somewhat more argon than is usually dissolved when air is shaken with water. In the spring of 1896 Mr. Travers and I made a trip to the Pyrenees to collect gas from the mineral springs of Cauterets, to which our attention had been directed by Dr. Bouchard, who pointed out that these gases are rich in helium. We examined a number of samples from the

various springs, and confirmed Dr. Bouchard's results, but there was no sign of any unknown lines in the spectrum of these gases. Our quest was in vain.

We must now turn to another aspect of the subject. Shortly after the discovery of helium its spectrum was very carefully examined by Professors Runge and Paschen, the renowned spectroscopists. The spectrum was photographed, special attention being paid to the invisible portions, termed the 'ultra-violet' and 'infra-red.' The lines thus registered were found to have a harmonic relation to each other. They admitted of division into two sets, each complete in itself. Now, a similar process had been applied to the spectrum of lithium and to that of sodium, and the spectra of these elements gave only one series each. Hence, Professors Runge and Paschen concluded that the gas, to which the provisional name of helium had been given, was, in reality, a mixture of two gases, closely resembling each other in properties. As we know no other elements with atomic weights between those of hydrogen and lithium, there is no chemical evidence either for or against this supposition. Professor Runge supposed that he had obtained evidence of the separation of these imagined elements from each other by means of diffusion; but Mr. Travers and I pointed out that the same alteration of spectrum, which was apparently produced by diffusion, could also be caused by altering the pressure of the gas in the vacuum tube; and shortly after Professor Runge acknowledged his mistake.

These considerations, however, made it desirable to subject helium to systematic diffusion, in the same way as argon had been tried. The experiments were carried out in the summer of 1896, by Dr. Collie and myself. The result was encouraging. It was found possible to separate helium into two portions of different rates of diffusion, and consequently of different density by this means. The limits of separation, however, were not very great. On the one hand, we obtained gas of a density close on 2.0; and on the other, a sample of density 2.4 or thereabouts. The difficulty was increased by the curious behavior, which we have often had occasion to confirm, that helium possesses a rate of diffusion too rapid for its density. Thus, the density of the lightest portion of the diffused gas, calculated from its rate of diffusion, was 1.874; but this corresponds to a real density of about 2.0. After our paper, giving an account of these experiments, had been published, a German investigator, Herr A. Hagenbach, repeated our work and confirmed our results.

The two samples of gas of different density differ also in other properties. Different transparent substances differ in the rate at which they allow light to pass through them. Thus, light travels through water at a much slower rate than through air, and at a slower rate through air than through hydrogen. Now Lord Rayleigh found that helium offers less opposition to the passage of light than any other substance does, and the heavier of the two portions into which helium had been split offered more opposition than the lighter portion. And the retardation of the light, unlike what has usually been observed, was nearly proportional to the densities of the samples. The spectrum of these two samples did not differ in the minutest particular; therefore it did not appear quite out of the question to hazard the speculation that the process of diffusion was instrumental, not necessarily in separating two kinds of gas from each other, but actually in removing light molecules of the same kind from heavy molecules. This idea is not new. It had been advanced by Prof. Schützenberger (whose recent death all chemists have to deplore), and later, by Mr. Crookes, that what we term the atomic weight of an

element is a mean; that when we say that the atomic weight of oxygen is 16 we merely state that the average atomic weight is 16; and it is not inconceivable that a certain number of molecules have a weight somewhat higher than 32, while a certain number have a lower weight.

We therefore thought it necessary to test this question by direct experiment with some known gas; and we chose nitrogen, as a good material with which to test the point. A much larger and more convenient apparatus for diffusing gases was built by Mr. Travers and myself, and a set of systematic diffusions of nitrogen was carried out. After thirty rounds, corresponding to 180 diffusions, the density of the nitrogen was unaltered, and that of the portion which should have diffused most slowly, had there been any difference in rate, was identical with that of the most quickly diffusing portion, *i. e.*, with that of the portion which passed first through the porous plug. This attempt, therefore, was unsuccessful; but it was worth carrying out, for it is now certain that it is not possible to separate a gas of undoubted chemical unity into portions of different density by diffusion. And these experiments rendered it exceedingly improbable that the difference in density of the two fractions of helium was due to separation of light molecules of helium from heavy molecules.

The apparatus used for diffusion had a capacity of about two litres. It was filled with helium, and the operation of diffusion was carried through thirty times. There were six reservoirs, each full of gas, and each was separated into two by diffusion. To the heavier portion of one lot the lighter portion of the next was added, and in this manner all six reservoirs were successively passed through the diffusion apparatus. This process was carried out thirty times, each of the six reservoirs having had its gas diffused each time thus involving 180 diffusions.

After this process the density of the more quickly diffusing gas was reduced to 2.02, while that of the less quickly diffusing had increased to 2.27. The light portion on re-diffusion hardly altered in density, while the heavier portion, when divided into three portions by diffusion, showed a considerable difference in density between the first third and the last third. A similar set of operations was carried out with a fresh quantity of helium, in order to accumulate enough gas to obtain a sufficient quantity for a second series of diffusions. The more quickly diffusing portions of both gases were mixed and re-diffused. The density of the lightest portion of these gases was 1.98, and after other 15 diffusions the density of the lightest portion had not decreased. The end had been reached; it was not possible to obtain a lighter portion by diffusion. The density of the main body of this gas is therefore 1.98; and its refractivity, air being taken as unity, is 0.1245. The spectrum of this portion does not differ in any respect from the usual spectrum or helium.

As re-diffusion does not alter the density or the refractivity of this gas, it is right to suppose that either one definite element has now been isolated or that if there are more elements than one present they possess the same, or very nearly the same, density and refractivity. There may be a group of elements, say three, like iron, cobalt and nickel; but there is no proof that this idea is correct and the simplicity of the spectrum would be an argument against such a supposition. This substance, forming by far the larger part of the whole of the gas, must, in the present state of our knowledge, be regarded as pure helium.

On the other hand, the heavier residue is easily altered in density by re-diffusion, and this would imply that it consists of a

small quantity of a heavy gas mixed with a large quantity of the light gas. Repeated re-diffusion convinced us that there was only a very small amount of the heavy gas present in the mixture. The portion which contained the largest amount of heavy gas was found to have the density 2.275, and its refractive index was found to be 0.1333. On re-diffusing this portion of gas until only a trace sufficient to fill a Plücker's tube was left, and then examining the spectrum, no unknown lines could be detected, but, on interposing a jar and spark gap, the well-known blue lines of argon became visible; and even without the jar the red lines of argon and the two green groups were distinctly visible. The amount of argon present, calculated from the density, was 1.64 per cent., and from the refractivity 1.14 per cent. The conclusion had therefore to be drawn that the heavy constituent of helium, as it comes off the minerals containing it, is nothing new, but, so far as can be made out, merely a small amount of argon.

If, then, there is a new gas in what is generally termed helium, it is mixed with argon, and it must be present in extremely minute traces. As neither helium nor argon has been induced to form compounds, there does not appear to be any method, other than diffusion, for isolating such a gas, if it exists, and that method has failed in our hands to give any evidence of the existence of such a gas. It by no means follows that the gas does not exist; the only conclusion to be drawn is that we have not yet stumbled on the material which contains it. In fact, the haystack is too large and the needle too inconspicuous. Reference to the periodic table will show that between the elements aluminium and indium there occurs gallium, a substance occurring only in the minutest amount on the earth's surface; and following silicon, and preceding tin, appears the element germanium, a body which has as yet been recognized only in one of the rarest of minerals, argyrodite. Now, the amount of helium in fergusonite, one of the minerals which yields it in reasonable quantity, is only 33 parts by weight to 100,000 of the mineral; and it is not improbable that some other mineral may contain the new gas in even more minute proportion. If, however, it is accompanied in its still undiscovered source by argon and helium, it will be a work of extreme difficulty to effect a separation from these gases.

In these remarks it has been assumed that the new gas will resemble argon and helium in being indifferent to the action of reagents, and in not forming compounds. This supposition is worth examining. In considering it the analogy with other elements is all that we have to guide us.

We have already paid some attention to several triads of elements. We have seen that the differences in atomic weights between the elements fluorine and manganese, oxygen and chromium, nitrogen and vanadium, carbon and titanium, is in each case approximately the same as that between helium and argon, viz., 36. If elements further back in the periodic table be examined, it is to be noticed that the differences grow less, the smaller the atomic weights. Thus, between boron and scandium, the difference is 33; between beryllium (glucinum) and calcium, 31; and between lithium and potassium, 32. At the same time, we may remark that the elements grow liker each other the lower the atomic weights. Now helium and argon are very like each other in physical properties. It may be fairly concluded, I think, that in so far they justify their position. Moreover, the pair of elements which show the smallest difference between their atomic weights is beryllium and calcium; there is somewhat greater difference between lithium and potassium. And, it is in accordance

with this fragment of regularity that helium and argon show a greater difference. Then, again, sodium, the middle element of the lithium triad, is very similar in properties both to lithium and potassium; and we might, therefore, expect that the unknown element of the helium series should closely resemble both helium and argon.

Leaving now the consideration of the new element, let us turn our attention to the more general question of the atomic weight of argon, and its anomalous position in the periodic scheme of the elements. The apparent difficulty is this: The atomic weight of argon is 40; it has no power to form compounds, and thus possesses no valency; it must follow chlorine in the periodic table, and precede potassium; but its atomic weight is greater than that of potassium, whereas it is generally contended that the elements should follow each other in the order of their atomic weights. If this contention is correct, argon should have an atomic weight smaller than 40.

Let us examine this contention. Taking the first row of elements, we have:

$$Li=7,\ Be=9.8,\ B=11,\ C=12,\ N=14,\ O=16,\ F=19,\ ?=20.$$

The differences are:

2.8, 1.2, 1.0, 2.0, 2.0, 3.0, 1.0.

It is obvious that they are irregular. The next row shows similar irregularities. Thus:

$$(?=20),\ Na=23,\ Mg=24.3,\ Al=27,\ Si=28,\ P=31,\ S=32,\ Cl=35.5,\ A=40.$$

And the differences:

3.0, 1.3, 2.7, 1.0, 3.0, 1.0, 3.5, 4.5.

The same irregularity might be illustrated by a consideration of each succeeding row. Between argon and the next in order, potassium, there is a difference of —0.9; that is to say, argon has a higher atomic weight than potassium by 0.9 unit; whereas it might be expected to have a lower one, seeing that potassium follows argon in the table. Farther on in the table there is a similar discrepancy. The row is as follows:

$$Ag=108,\ Cd=112,\ In=114, Sn=119,\ Sb=120.5,\ Te=127.7,\ I=127.$$

The differences are:

4.0, 2.0, 5.0, 1.5, 7.2, —0.7.

Here, again, there is a negative difference between tellurium and iodine. And this apparent discrepancy has lead to many and careful redeterminations of the atomic weight of tellurium. Professor Brauner, indeed, has submitted tellurium to methodical fractionation, with no positive results. All the recent determinations of its atomic weight give practically the same number, 127.7.

Again, there have been almost innumerable attempts to reduce the differences between the atomic weights to regularity, by contriving some formula which will express the numbers which represent the atomic weights, with all their irregularities. Needless to say, such attempts have in no case been successful. Apparent success is always attained at the expense of accuracy, and the numbers reproduced are not those accepted as the true atomic weights. Such attempts, in my opinion, are futile. Still, the human mind does not rest contented in merely chronicling such an irregularity; it strives to understand why such an irregularity should exist. And, in connection with this, there are two matters which call for our consideration. These are: Does some circumstance modify these 'combining proportions' which we term 'atomic weights'? And is there any reason to suppose that we can modify them at our will? Are they true 'constants of Nature' unchangeable, and once for all determined? Or are they constant merely so long as other circumstances, a change in which would modify them, remain unchanged.

In order to understand the real scope of

such questions, it is necessary to consider the relation of the 'atomic weights' to other magnitudes, and especially to the important quantity termed 'energy.'

It is known that energy manifests itself under different forms and that one form of energy is quantitatively convertible into another form, without loss. It is also known that each form of energy is expressible as the product of two factors, one of which has been termed the 'intensity factor,' and the other the 'capacity factor.' Professor Ostwald, in the last edition of his 'Allgemeine Chemie,' classifies some of these forms of energy as follows:

Kinetic energy is the product of Mass into the square of velocity.

Linear energy is the product of Length into force.

Surface energy is the product of Surface into surface tension.

Volume energy is the product of Volume into pressure.

Heat energy is the product of Heat-capacity (entropy) into temperature.

Electrical energy is the product of Electric capacity into potential.

Chemical energy is the product of 'Atomic weight' into affinity.

In each statement of factors, the 'capacity factor' is placed first, and the 'intensity-factor' second.

In considering the 'capacity factors,' it is noticeable that they may be divided into two classes. The two first kinds of energy, kinetic and linear, are *independent of the nature of the material* which is subject to the energy. A mass of lead offers as much resistance to a given force, or, in other words, possesses as great inertia as an equal mass of hydrogen. A mass of iridium, the densest solid, counterbalances an equal mass of lithium, the lightest known solid. On the other hand, surface energy deals with molecules, and not with masses. So does volume energy. The volume energy of two grammes of hydrogen, contained in a vessel of one litre capacity, is equal to that of thirty-two grammes of oxygen at the same temperature and contained in a vessel of equal size. Equal masses of tin and lead have not equal capacity for heat; but 119 grammes of tin has the same capacity as 207 grammes of lead, that is, equal atomic masses have the same heat capacity. The quantity of electricity conveyed through an electrolyte under equal difference of potential is proportional, not to the mass of the dissolved body, but to its equivalent, that is, to some simple fraction of its atomic weight. And the capacity factor of chemical energy is the atomic weight of the substance subjected to the energy. We see, therefore, that while mass or inertia are important adjuncts of kinetic and linear energies all other kinds of energy are connected with atomic weights, either directly or indirectly.

Such considerations draw attention to the fact that quantity of matter (assuming that there exists such a carrier of properties as we term 'matter') need not necessarily be measured by its inertia, or by gravitational attraction. In fact, the word 'mass' has two totally distinct significations. Because we adopt the convention to measure quantity of matter by its mass, the word 'mass' has come to denote 'quantity of matter.' But it is open to anyone to measure a quantity of matter by any other of its energy factors. I may, if I choose, state that those quantities of matter which possess equal capacities for heat are equal, or that 'equal numbers of atoms' represent equal quantities of matter. Indeed, we regard the value of material as due rather to what it can do than to its mass; and we buy food, in the main, on an atomic, or, perhaps, a molecular basis, according to its content of albumen. And most articles depend for their value on the amount of food required by the producer or the manufacturer.

The various forms of energy may, there-

fore, be classified as those which can be referred to an 'atomic' factor, and those which possess a 'mass' factor. The former are in the majority. And the periodic law is the bridge between them; as yet, an imperfect connection. For the atomic factors, arranged in the order of their masses, display only a partial regularity. It is undoubtedly one of the main problems of physics and chemistry to solve this mystery. What the solution will be is beyond my power of prophecy; whether it is to be found in the influence of some circumstance on the atomic weights, hitherto regarded as among the most certain 'constants of Nature,' or whether it will turn out that mass and gravitational attraction are influenced by temperature, or by electrical charge, I cannot tell. But that some means will ultimately be found of reconciling these apparent discrepancies, I firmly believe. Such a reconciliation is necessary, whatever view be taken of the nature of the universe and of its mode of action; whatever units we may choose to regard as fundamental among those which lie at our disposal.

In this address I have endeavored to fulfill my promise to combine a little history, a little actuality and a little prophecy. The history belongs to the Old World; I have endeavored to share passing events with the New; and I will ask you to join with me in the hope that much of the prophecy may meet with its fulfilment on this side of the ocean.

William Ramsay.

ADDRESS BY THE PRESIDENT BEFORE THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

In opening the proceedings of this fourth annual meeting of the Society for the Promotion of Engineering Education I wish, first of all, to congratulate the Society upon its great success thus far in accomplishing the object for which it was founded, an object fully expressed in its name. The volumes of its proceedings already published are filled with discussions and the ripe conclusions of the best thought that can be expressed to-day upon many phases of engineering education. No one who desires to become informed upon these matters can afford to neglect these volumes. It is believed that all interested in the object of our Society will find it to their advantage to unite with us.

One striking peculiarity of engineering education seems to me to lie in the fact that it has been determined so largely as to its scope and the lines of its development by the engineering colleges themselves in advance of the formulated demands of the engineering profession and of the public in general, and often, indeed, in opposition to such demands. Through the wisdom and foresight of these organizers of engineering education the profession of engineering has come forth during this generation into public estimation as a learned and responsible profession, quite the peer of law or medicine. This is the work of the engineering colleges, and from the deliberations of this Society it is evident that they still have a large work before them. The educational institutions of our country are in a state of flux. The present movement in education is powerful. These times will be looked back to in future days as those in which mighty educational forces were inaugurated and were adapted to the needs of the nation just as it was coming to its full consciousness as one of the great family of nations, a consciousness of power and responsibility that is causing it to depart somewhat from the revered advice of Washington, which was to keep aloof from European affairs and entanglements with other nations of the earth and work out its own destiny by itself. National growth and our multiplied facilities for communication have greatly modi-

fied our feeling as to this. The triumphs of the engineer in applying steam and electricity are making of one blood all nations of the earth. But the one thing that is making and will make of us a nation worthy of our heritage is our educational life. Our republican institutions, the pride of our early national life, cannot continue such except for the reinforcement and help to come from the enlarged scope of education to-day.

It has seemed to me that I could not, perhaps, use the short time allotted to me for this address better than in trying to summarize some of the thoughts which have appeared in the papers and discussions before this Society, which had its beginning in the Engineering Congress of the Columbian Exposition at Chicago. What I have to say is called forth by the enlarged responsibilities and new conception of the professional position of the engineer of to-day, and the course of study necessary to fit him for the responsibilities of his position.

And, first of all, I think I am right in saying that the demand is growing stronger that courses of engineering instruction shall include nothing else, that is, that they shall be as completely professional in their character as are professional courses in law and medicine.

This demand is not made by the general public, nor to any great extent, I think, by practicioners in the engineering profession. These are greatly impressed with the necessity the engineer has for general culture, and rightly so. The demand is one made by the engineering colleges themselves. At present the curriculum of our average engineering college includes from 20 to 25 per cent. of culture studies, such as English, French and German; from 30 to 25 per cent. of indirectly technical study, as Mathematics, Physics, etc.; and 50 per cent. of directly technical study.

The culture studies are of fundamental importance to the engineer. He usually obtains far too small an amount of such study before graduation. He finds himself poorly fitted in this respect for his subsequent career. His preparation in the use of language for writing and speaking has been too meager. He finds that his professional work is not of a character to supplement his education in this particular. Yet culture studies are out of place in any engineering course with strongly marked technical tendencies. Both student and instructor feel this. The two kinds of study interfere with each other. The student cannot fix his attention on culture study while absorbed in the beginnings of technical study. The instructor in the culture studies feels the hopelessness of the task and must perforce be content with a lifeless, memoriter fulfilment of task work. The instructors in the technical studies are apt to be impatient at the time and attention demanded by the culture studies as more or less of an obstacle and hindrance to what is rightly regarded as the student's main work.

Under such circumstances as these it seems clear that the culture studies must soon disappear from our engineering courses. This change will, doubtless, come about gradually and will occur in the more fully developed courses first. It will not mean that culture studies shall be omitted from the education of the engineer. It will simply mean that he must obtain them outside of the engineering course, preferably before he enters it. The tendency, on every hand, is to insist more strongly than heretofore upon the culture studies as essential to the engineer. To insure large success he must be a man of broad culture. He is to direct large enterprises as well as plan the necessary structure and machinery of the plant, and that man will succeed who by the influence of his personality, with

tongue and pen, shows himself able to hold his position as the peer of other great organizers of our industrial life. The highest success is to be quickly reached as a rule only by those engineers who have had adequate preliminary education in culture studies, which is another name for the liberal arts. Such culture is now most readily and suitably attained by pursuing some part, more or less complete, of a regular college course. This will come to be regarded more and more as the best preparation for a professional course in engineering, as it is now for a professional course in law and medicine.

Following the consideration of the culture studies comes that of the indirectly technical studies, such as mathematics, mechanics, physics, chemistry and drawing, which at the present time occupy between one-third and one-fourth of the time of the average engineering course. These studies rightfully have place in the course, but the question whether the amount and quality of the work at present accomplished is entirely satisfactory is one which has been much debated. It may be said fairly, I think, that the standard of work in mathematics, mechanics and physics has been gradually but surely advancing in all the engineering colleges, against the opposition of a large part of those engaged in engineering practice, who have been largely opposed to teaching more mathematics, etc., than they themselves were taught, saying that they have had no use for much of that which was taught them. This argument has seemed perfectly conclusive to those who have advanced it, and also to the student, who naturally finds such studies hard, and (as he thinks) much in the way of his rapidly advancing to purely technical study. This view has also often met acceptance with the technical professors, who are largely in sympathy with those engaged in practice. But the argument is fallacious, as I am convinced. The contrary view has prevailed in the papers before this Society. We are to look upon this gradual advance of the standard in mathematics, etc., as a movement which has not as yet ceased, but one still in progress.

Perhaps the point of greatest difficulty, so far as mathematics is concerned, has been to have the differential and integral calculus so incorporated into the engineering courses as to really become part of the working equipment of the student. That may not have been completely accomplished as yet, but that is the standard now regarded as essential, and one which is more and more nearly attained year by year. It is my opinion that it will not be satisfactorily reached until the course in calculus includes the treatment of differential equations. This conclusion is forced upon me, not merely by the abstract consideration that physical and mechanical questions find their expression best by the use of differential equations ; but the problems arising just now in the theory of alternating currents must evidently be treated on the basis of their differential equations. Heretofore it has been possible to satisfy the student as to the treatment and solution of the mechanical and physical problems in his course without special study of differential equations, though he was likely to meet a number of points that were puzzling and unsatisfactory by reason of his ignorance of that subject. But now the matter can no longer be avoided, I think, as no other treatment can give the necessary insight into the complicated phenomena which must be fully mastered to-day by the student in electricity.

Mechanics, too, and physics have taken on a larger and larger significance. The principles of mechanics underlie all physical phenomena and all engineering processes. Their formal study has been found to be of increasing importance in under-

standing the strength and resistance of materials, the thermodynamics of steam- and gas-engines, turbines, electrical generators, motors and transformers.

As to physics and chemistry it is unnecessary for me to explain how small are the opportunities compared with what is desirable. The state of knowledge in these sciences is steadily advancing. Hertz waves and Röntgen rays are meeting technical applications, and new knowledge must have place. The field constantly increases. More time must be taken for such subjects. We cannot escape it. It seems impracticable to secure it by having more physics and chemistry taught in the preparatory schools. Such work is not satisfactory. It is preferable to relegate more of the pure mathematics to those schools.

We are to look in the future, as I think, for an increase in the amount and an improvement in the quality of the work in all that part of the work in our engineering courses, which, though but indirectly technical, affords the theoretical basis of the strictly technical studies of the course.

The improvement in the quality of the instruction will lie, for one thing, along the line of the illustrations and problems employed, in seeing to it that they have to do with things tangible and in the direction of practice. This will help secure the necessary interest in theory and make it, as it should be, the basis of practice.

We now come to the consideration of those studies which are strictly and directly technical. They occupy in most engineering courses at least one half of the course. The improvements which have taken place in engineering courses have occurred more largely in this part of the work than elsewhere, but great divergence of opinion has naturally arisen as to what is best. In certain courses of mechanical engineering an excessive amount of manual training and shop work was at first introduced; inexpert opinion still lays undue emphasis upon this part of the course in mechanical and electrical engineering. But as the true function of manual training and trades schools comes to be better understood, and their value to the community in developing handicraft and in furnishing education to the artisan as distinguished from the professional engineer, not only will such schools be well supported and greatly increased in number, but they will be sharply distinguished in the minds of all from the engineering colleges. These last are not intended to make skilled workmen, though some seem still to think so. The engineering student needs a comparatively small amount of practice in wood working, which shall be especially directed toward pattern making; a short experience in the blacksmith shop and foundry, and somewhat more of metal working by hand and machine tools, together with the management of boilers and steam engines. But any effort to make prolonged exercises in these subjects take the place of more theoretical study in an endeavor to make a workman or a foreman instead of an engineer.

The same is true of extended civil engineering field practice with instruments. It is quite possible to put too great emphasis upon it and consume more time with it than the study warrants. The temptation to do that is strong. It must be remembered, however, that surveying is not today the principal occupation of most engineers. The plan of putting shop practice, field work and other like practical parts of the course into the long vacations has much in its favor and seems to be coming more into vogue. The student should graduate from the shop and the surveying corps as soon as he has obtained a moderately good acquaintance with tools and processes and enter the testing laboratory. That is the true field for extended practical work in

the engineering course. In it the work should be arranged with regular sets of graded exercises covering the measurement, proper records and working out the results of tests on all the materials and processes treated in the theoretical work of the student as well as whatever he is likely to encounter in practice or inspection. It is only by prolonged drill in testing that he can acquire the necessary basis for that professional and practical judgment which will make his opinion of value. While thus insisting on testing laboratories as the best and most important recent development of our engineering colleges as well as one of the most costly parts of them, it is needful to insist at the same time and with still greater emphasis on the paramount importance of the theoretic instruction in the mathematical, mechanical and scientific principles which should furnish the core of every engineering course. This it is which engineering colleges must teach and trades schools may entirely omit. Engineering colleges may leave out shops and laboratories, and some do so; they may omit culture studies, and have very imperfect instruction in drawing and design, without forfeiting the claim to give engineering courses of considerable value; but no engineering college can afford, at the risk of imperilling its reputation and usefulness, to neglect or slight, for any length of time, to put forth its best efforts to thoroughly indoctrinate its students in as complete and extended a theoretical treatment of the engineering subjects it teaches as the time at its disposal and the preparation of its students will permit. Drawing and designing, shop practice and testing, general culture and professional information, all are subsidiary and auxiliary to this one thing. Engineering courses at first began with little else in them of importance to the profession than this, and by it they have proved themselves indispensable to it. It is a mistake too frequently made by practitioners, deeply immersed in the details of their profession, to suppose that the most important and fruitful field of instruction is not just here.

Practice, experience, judgment will come in time to the young engineer even if he should not have it before graduation, but study and theory he will not usually thus attain to. That must be had before graduation or the engineering college has little excuse for existence.

This being granted, the fact still remains that the ultimate success of the engineer as a professional man depends upon his character and force as a man among men, upon his culture, upon his integrity, upon his tact and social power. In other professions such qualities receive continuous culture in the practice of the profession. It is far less so with the engineer. Here, then, is an argument for broad preliminary culture before entering upon engineering study, but it likewise points to something with which the engineering colleges have thus far not busied themselves to any appreciable extent, but which in the future cannot be neglected in justice to the position which the profession is called to occupy. Every engineering student has the right to careful instruction in a recognized code of professional ethics which shall instruct his conscience and fortify his will, and give him a satisfying consciousness of duty done to his professional brethren, to the public and to the judge of all the earth.

Until such instruction shall take its place in our engineering courses the public can never rely upon organized professional opinion to restrain unprofessional conduct, nor can individual members of the profession be sustained in courses of right action against the demands of corporations and combinations of capital. It remains, then, for engineering colleges to help organize the profession and to furnish the basis of such

organization in a code of professional ethics which shall be worthy, unifying and elevating.

One step further in this direction is also of importance, namely: Provision for such instruction in the law of contracts as will enable the engineer to discharge with confidence his professional obligations and protect the interests of his employers. For, it is not only necessary that he should have the scientific and technical knowledge to adapt the forces of nature to the projects in view, and exercise good judgment as to the best means of doing this, as well as have the ability fully and clearly to set forth his plans in a manner to carry conviction to those seeking his services; but it is also equally necessary that when entrusted with the responsibilities of actual construction he should be able so clearly and explicitly to set forth the rights and obligations of all parties, that disputes and legal difficulties may not arise, such as often are more costly and troublesome than errors of design. The place to obtain the necessary legal knowledge of specifications and contracts is during the professional engineering course.

It has been urged by some that economic design, as dependent upon the market price of materials, labor and power, should also find place in the engineering course, but the consensus of best opinion seems to draw the line here between education and practice. While the attention of the student should undoubtedly be drawn briefly, yet pointedly, to the economic limitations under which commercial work is done, the attempt to make designs under such limitations should be mostly left to the time when judgment has ripened and the complex conditions of practice are better known by experience. In fact, almost no undergraduate work can usefully reproduce competitive conditions, and the attempt to do this must usually be regarded with distrust. The aim of teaching is not an object lesson under business conditions, but thorough instruction in underlying principles, especially those theoretical and scientific principles which cannot be correctly estimated by the layman.

It will be noticed, in all the matters in which I have attempted to reflect the opinions which are current in the papers that have been presented to this Society and published in its proceedings, the movement and tendencies which I have sketched can be traced, all of them, to a single source, namely, to the position of influence and responsibility which the professional engineer has but recently come to occupy. That position is what it is to-day in the esteem and respect of the public largely through the wise efforts of the managers and instructors of the engineering colleges. Their work in moulding and directing the engineering education in the future will, I am persuaded, be no less important than in the past. That such guidance shall continue to be wise, its progress healthful, and costly mistakes be avoided, will be materially assisted by the deliberations and discussions of this Society.

The valuable report of the committee on entrance requirements, now in your hands, is an important piece of work, taking rank beside the other great educational reports upon the various phases of secondary education which have attracted such general attention during a few years past and have influenced so greatly the work of the preparatory schools as well as the requirements of the colleges.

I regard it as a happy omen that we are met to hold this meeting so early in our history here in Toronto, thereby expressing our interest in the promotion of engineering education as a branch of applied science, confined by no geographical boundaries or limitations, as well as our conviction that some of the most vital elements of human

progress will be moulded by the conclusions we shall reach. Let us address ourselves to the work before us with the same fraternal zeal that has characterized the meetings of the Society in the past, and that in fact is singularly characteristic of that noble body of men who practice the profession of engineering, a profession whose triumphs are our pride and whose future greatness it is the object of this Society to foster.

HENRY T. EDDY.
UNIVERSITY OF MINNESOTA.

ANTHROPOLOGY AT THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE section was organized August 9th, as follows: W J McGee, Chairman; Anita Newcomb McGee, M. D., Secretary (elected to fill the vacancy caused by the resignation of Harlan I. Smith); W. H. Holmes, Councillor; Alice C. Fletcher (*ex officio*), M. H. Saville, Frank Hamilton Cushing and Warren K. Moorehead, Sectional Committee-at-Large; Washington Matthews, General Nominating Committee; Lightner Witmer, Stephen D. Peet and Alois Hrdlicka, Nominating Committee-at-Large.

The meetings of the section were held in the most spacious of the class-rooms in the high school building, and were well attended not only by members of the Association, but by citizens of Detroit; the attendance ranged from 50 to 400, averaging fully 200. Special interest attached to the afternoon session of August 11th, which was a joint meeting of Sections E and H, in the room assigned to the latter, for discussion of the human relics from sand deposits in Delaware valley. A number of foreign guests, members of the British Association, attended this and other meetings of the section; among them were Dr. and Mrs. Robert Munro, of Edinburgh; Professor and Mrs. J. L. Myres, of Oxford; Prince Krapotkin, of Russia, latterly of Kent, England; Dr. Albrecht Penck, of Vienna; Professor Vernon Harcourt, of Oxford, and Dr. H. P. Truell, of Wicklow, Ireland.

The afternoon of August 9th was devoted to the Vice-Presidential address, which has appeared in this JOURNAL; and the morning session of August 10th was devoted mainly to a summary and continuation of the address, followed by a general discussion of the anthropologic classification suggested therein, in which Miss Fletcher, Dr. Munro, Professor Myres, Dr. Peet, Professor Witmer and others participated. Later a report was presented by Miss Fletcher on the Winter Conference of members of Section H held in New York last December. The section then voted to request authority from the Council to hold a formal meeting at Ithaca during the Christmas holidays of this year. (This meeting was duly authorized by the Council, and a small appropriation was made to cover cost of printing announcements, etc.)

The reading of the papers began with the afternoon session of August 10th. The first of these was an elaborate account of the superstitions, beliefs and practices of the ancient Mexicans, by Zelia Nuttall, read, in the absence of the author, by Dr. Saville. The material was mainly compiled from the records of early Spanish missionaries among the Aztecan Indians; it derived importance from the fact that these records are little known, and have not hitherto been brought to the attention of students of anthropology. The discussion by Dr. Hrdlicka and others indicated that many of the superstitions and ceremonies of the ancient Mexicans are duplicated among the more primitive peoples of different countries, notably those of central Europe.

'The Study of Ceremony,' by Dr. Washington Matthews, followed. The author expressed the conviction that the ceremonies

of primitive people are not merely worthy of scientific study, but are of sufficient extent and importance to serve as a basis for a distinct branch of science; and he illustrated his idea by describing the elaborate ceremonies of different Indian tribes and discussing the rise and decadence of fiducial practices among the American aborigines. He suggested several terms suitable for designating the study of ceremony, and invited the appointment of a sectional committee to consider the subject of nomenclature. After discussion of the paper by Dr. Peet and others, the section voted to appoint the committee suggested by Dr. Matthews, and Rev. Stephen D. Peet, Miss Alice Fletcher and Mr. Frank Hamilton Cushing were appointed as such committee.

Dr. Peet followed with a suggestive comparison of Cherokee and European symbolism, in which many curious parallels were brought out.

The next communication was 'Koreshanity: A Latter-Day Cult,' by Anita Newcomb McGee, M.D. The author described briefly a cult or religious system founded by Dr. Cyrus R. Teed, or Koresh (the Hebrew form of the prename Cyrus), and detailed the curious cosmogony bound up with the religious teaching. Although it gained foothold only within a dozen years, the doctrine has spread with such rapidity that the adherents number many hundred, perhaps thousands, of whom about 150 have entered a communistic organization with headquarters in Chicago and a colony in southwestern Florida. The communication was discussed by Professor Morse, Professor Witmer and others.

The work of the day ended with a paper on the origin of the week and holy day among primitive peoples, by Rev. R. J. Floody. Beginning with an account of the wide distribution of hebdomadal systems in different parts of the world, the author passed to explanations of the occurrence of such systems, and finally enunciated the proposition that such systems originated spontaneously among peoples in that culture-stage in which adoration of the sun, moon, etc., prevails; he held that the lunation of about 28 days is the simplest and most convenient time-measure longer than the day, and that it is naturally divisible, first into semi-lunations of relative dark and light, and then into quarter lunations defined by wax and wane with respect to full moon, 'dead' moon and intermediate half moon. An elaborate array of evidence in support of the idea, derived from primitive customs and also from folk-lore and even modern customs, was presented, and the easy development of the sacred day in connection with the moon-defined seven-day period was pointed out.

The morning session of August 11th was devoted to Mexican archæology. The first paper was a brief account, by Professor F. W. Putnam, of recent researches by George Byron Gordon on the banks of the Ulloa River in Honduras, made for the Peabody Museum. Professor W. H. Holmes followed with an account of 'The Building of a Zapotec City,' in which he sketched briefly the history of the ruined city of Mitla, as viewed from the standpoint of the builder's art. He illustrated the subject by selecting an ordinary edifice and describing the several stages in construction, beginning with the preparation of the material by quarrying and cutting the stone, passing to the masonry construction and then describing the roofing and surface embellishment; examples of the materials and of the quarrying and cutting implements — almost wholly of stone—were exhibited. Dr. Saville then noted 'The Geographic Distribution of a Certain Kind of Pottery found in Mexico and Central America;' this ware is characterized by a peculiar steel blue-gray lustre, more nearly approaching a true glaze than any surface finish heretofore

known in ancient America, of which twenty-six specimens have been found in widely separated localities from Tapec, Mexico, to Copan, Honduras; he expressed the opinion that the specimens were originally made about Alta Very Paz, Guatemala. Dr. Peet then discussed 'The Serpent Symbol in Nicaraugua,' noting the great contrast with the corresponding symbol found in the eastern part of the continent, and pointing out that in the East the serpent was generally regarded as evil or inimical to mankind, while in Nicaraugua it was considered a beneficent deity. The reasons for this diversity in belief were examined at length, and reference was made to the serpent symbol and its meaning in other parts of the world. The author expressed the conviction that, while the theory of parallel development (*i. e.*, the doctrine of activital coincidence, which has recently grown prominent, especially among American anthropologists) was strongly suggested by the facts, it could hardly be accepted as a full explanation of the similarities and dissimilarities noted. The paper was discussed by several members, notably Dr. Munro, who expressed some skepticism concerning the prevalence of serpent worship and mentioned instances of manifest error in the interpretation of artificial and even natural objects as serpent symbols. Mr. Stansbury Hagar contributed remarks concerning the Micmac and other Indians.

The afternoon was devoted to a symposium on the question of early man in Delaware valley. The Section of Geology (under Professor E. W. Claypole as Vice-President) participated. Brief papers by Messrs. H. B. Kümmel and G. G. Knapp were first presented, in the absence of the authors, by Professor R. D. Salisbury. Professor Putnam then gave a detailed account (illustrated by numerous diagrams, photographs and specimens) of the work of his assistant, Mr. Ernest Volk, in searching for human relics in the deposits about Trenton, New Jersey. It was shown that there is here a relic-bearing deposit of sand containing ferruginous bands, ranging from two feet or less to three or four feet in thickness; and photographs and other records were exhibited, showing the occurrence of artificial chips, spalls, flakes, and more or less perfect implements of argillite, quartz, etc., in this deposit to the depth of nearly or quite three feet, the abundance diminishing downward. Professor Putnam especially pointed out that, so far as his observations had gone, the artifacts of argillite predominate below, those of other materials above; he also held that these argillite objects were of the type known in Europe as paleolithic, while he regarded the more superficial artifacts as neolithic. He was followed by Professor G. F. Wright, who argued (1) that the ferruginous bands in the sand are marks of stratification, hence (2) that the deposit is water-laid, and (3) that its age corresponds with that of the later glacial deposits further northward in Delaware valley, *i. e.*, that it is Pleistocene.

Professor Holmes then exhibited a series of diagrams and other illustrations representing the geographic and geologic conditions of the relic-bearing deposits about Trenton. He first described the extensive deposit or series of deposits, reaching forty feet or more in thickness and consisting of gravel with some loam, which were undoubtedly formed during the glacial period. He pointed out that these were the deposits from which human relics were first reported at Trenton, and dwelt on the extended researches of over a dozen skilled archæologists and geologists who had been unable to find artifacts in undisturbed portions of these deposits, though they were found in the talus which unskilled observers sometimes mistook for the undisturbed deposits; and on this body of negative, yet abundant and cumulative, evidence he ex-

cluded these older deposits from consideration in connection with the question at issue. Taking up the later sand deposit, he showed that it is superficial and of limited extent, and of so slight depth as not to preclude the probability that all of the artificial material might have worked its way down from the surface; he also pointed out that this deposit appears to rest unconformably on the Pleistocene deposits, and gives other indications of being much newer. Passing then to the distribution of objects and materials, he showed that the artifacts diminish gradually and with fair uniformity downward, the distribution following the law displayed by organic matter and other substances originating at the surface; he also noted that his observations and those of his collaborators indicate no perceptible difference in frequency of argillite and other materials at the surface and at the greater depths, and exhibited photographs and specimens showing the occurrence of a finished quartz blade at about the maximum depth of human relics. In his introductory remarks and incidentally later he pointed out that, whether the artifacts be regarded as paleolithic or neolithic, they are precisely such as were found in use among the Algonquian Indians living on the site up to the time of white settlement. A brief paper by Thomas Wilson was read, in the absence of the author; it was chiefly an expression of conviction that a part of the argillite material should be classed as paleolithic.

Speaking on behalf of the geologists, Professor Claypole discussed the processes of ferrugination, and pointed out that the ferruginous bands illustrated in the diagrams and photographs could not be regarded as stratification lines, or as evidence of the aqueous origin of the sand-beds. Professor Salisbury, the geologist in charge of the State and Federal Surveys in the district, then discussed the geologic relations of the deposits; he described the thick beds of gravel and loam (which he had examined repeatedly without finding artificial material) as aqueo-glacial in origin and hence Pleistocene, and observed that the local and superficial bed of sand is younger, and was probably formed after the present river channel was excavated, at least in part, in the older deposits; he held that there was no decisive evidence that these sands were water-laid, that all of their phenomena could be explained otherwise, and that it was at least equally probable that they are eolian and perhaps quite recent. Professor T. C. Chamberlain emphasized the uncertainty as to the origin and age of the deposits developed by the elaborate studies of Salisbury, Kümmel, Knapp and others, and counseled caution in basing sweeping conclusions on so questionable premises. Dr. Penck described a somewhat parallel case in Europe, in which the question as to the age of relic-bearing deposits was set at rest by the finding of Roman objects associated with the artifacts of stone. Dr. Munro questioned whether any of the objects exhibited were paleolithic in the sense in which that term is used in Europe, and expressed doubt as to whether any trustworthy evidence of paleolithic man has been found west of the Atlantic. In response to a call, Mr. G. K. Gilbert questioned the validity of the supposed evidence of paleolithic man in Delaware valley, and mentioned cases coming under his own observation in which natural and artificial material was commingled in recent deposits.

Rising in rejoinder, Professor Putnam alluded to the discovery of an artifact beneath a large bowlder, apparently in place in the older gravels, and mentioned the finding of a human cranium, apparently of Eskimoan type, in the same deposit; and he reiterated his confidence in the prevalence of argillite materials of paleolithic character in the basal layers of the sand

beds. Professor Salisbury reviewed the geologic discussion, pointing out that the relations were such that, if the objects under consideration were fossils, no geologist would think of regarding the association as significant; and Professor Holmes recalled attention to the fact that the argillite artifacts are indistinguishable from those produced by Indians living in that vicinity up to the beginning of the present century.

The symposium was notable for the thorough knowledge of the facts displayed by several participants, as well as for the courtesy with which it was conducted.

The morning session of August 12th was opened with the exhibition of an archæologic map of Ohio by Warren K. Moorehead, who described the methods pursued in his archæologic survey of the State. The map received favorable comment throughout the section as representing the most ambitious and successful work of the kind thus far undertaken in America. The next paper, 'The Import of the Totem—a Study of the Omaha Tribe,' by Miss Alice Fletcher, was a remarkably full yet concise memoir representing the results of thorough study. It was favorably discussed by Dr. Matthews, Dr. Peet, Professor Myers and others (it will appear elsewhere in this Journal).

The afternoon session commenced with two elaborate papers illustrated by photographs, on the Tagbanua and the Mangyan tribes of the Phillipines, by Professor Dean C. Worcester; the tribes being discussed separately by reason of important differences in their customs and beliefs. Their physical characteristics, their marriage and mortuary customs, their arts and industries and their beliefs were described in detail. Then came a full account of the anthropologic work of the New York Pathological Institute, by Dr. Hrdlicka, the Superintendent. The chief object of this work is the establishment of average or normal standards, physical, physiologic and psychologic, especially of American-born people; the methods or ancillary purposes were fully set forth and the value of the work was shown. This paper was followed by two suggestive papers by Harlan I. Smith, viz.: 'The Ethnologic Arrangement of Archæologic Material,' and 'Popular Anthropology in Museums,' read, in the absence of the author, by Dr. Saville.

On August 13th the session was opened by an attractive paper, illustrated by numerous diagrams and tables, entitled 'An Experimental Analysis of the Relations of Rate of Movement to certain other Mental and Physical Processes,' by Dr. Lightner Witmer. The results of the investigations described were full and far-reaching, and will doubtless be presented in some detail elsewhere. There followed 'A Statistical Study of Eminent Men,' by Professor J. McKeen Cattell; it was presented by the Chairman in the absence of the author. It involved the application of a somewhat arbitrary method of measuring eminence quantitatively on the basis of the space devoted to individual biographies in certain selected encyclopedias and biographical dictionaries; and, after finding the thousand most eminent men of the world in this manner, their distribution was discussed by time, race, nation, etc. The results were illustrated by diagrams. The paper was freely discussed by several members. 'A Case of Trephining in Northwestern Mexico,' by Carl Lumholtz, was presented, in the absence of the author, by Dr. Hrdlicka; it was deemed specially noteworthy as one of the most northerly examples thus far known of a primitive art which attained great development in Peru; and also because of the suggestion, derived from the form of aperture, that the operation was performed by tubular drilling something after the fashion pursued in the modern operation. The next communication was 'A Description of a Pre-Aztec Skeleton found

in Adobe Deposits in the Valley of Mexico,' by Dr. Lumholtz and Dr. Hrdlicka; it was presented by the junior author, and illustrated by photographs, diagrams and tables. The skeleton presents several remarkable features which were described in detail; in general it is of strikingly low somatic type. The characters, particularly of the skull, differ from those of the Aztec or Nahuatlan and approach those of other ancient inhabitants of the same valley, especially the so-called Toltecs. The paper was discussed at length by Dr. Matthews, Professor Morse and others, the former pointing out, by reference to many examples, the general fact that supposedly low somatic characters frequently result from the form of exercise determined by the habits of life of certain tribes; he referred especially to the olecranon perforation, which he ascribes to the custom of grinding on the metate. Several papers were then read by title, and the scientific work of the section was brought to a close by a highly suggestive communication on 'The Genesis of Implement Making,' by Frank Hamilton Cushing, which will appear elsewhere in this JOURNAL.

The session was brought to an end within the last minute of the time allotted to the sectional work at the Detroit meeting, every moment of the working time having been occupied. In a vote of thanks to the presiding officer of the section, courteously presented by Miss Fletcher, special reference was made to this activity; and in seconding the motion, ex-President Morse observed that, during the many years of his connection with the Association, he had never seen the sectional work performed with so great harmony and scientific zest.

ANITA NEWCOMB MCGEE, *Secretary*.

COLUMBIA UNIVERSITY ZOOLOGICAL EXPEDITION OF 1897.

THE results obtained by the zoological expedition sent out by Columbia University in the summer of 1896 were so valuable as to warrant a second expedition to continue the examination of the waters of the northwest Pacific coast. It was decided this year to carry the exploration to Alaska and to examine new regions on Puget Sound, in the vicinity of Port Townsend.

As before, the party obtained the most satisfactory rates from the Canadian Pacific Railroad, and it gives me great pleasure to say that the magnificence and grandeur of the scenery along the route is not the only recommendation for the road. The great care taken for the safety of their passengers, together with many courtesies and polite attentions which we received from every official with whom we came in contact, added greatly to the pleasures of the trip.

I also take this occasion to thank Lieutenant Hetherington, U. S. N., of the Bremerton Naval Station, for many courtesies shown us both before and after our arrival at Port Orchard.

The original members of the party were G. N. Calkins (in charge), N. R. Harrington, B. B. Griffin, J. H. McGregor and F. P. Keppel. Professor E. B. Wilson and Professor F. E. Lloyd joined the party somewhat later. We reached Port Townsend, which again was to be our headquarters, on the morning of June 16th. There was little to be done at this time, for our experience last year had shown that few of the marine forms were ripe so early in the season. We added a few new species, however, to our collection of last year; among them were three siphonophores (*Monophyes*, *Diphyes* and *Physophora*); one ctenophore (Beroë); five medusæ, one nudibranch mollusc; one turbellarian, a lizard and a snake, but our attention was turned mostly towards our anticipated excursions to Port Orchard, to Sitka, Alaska, and to Neah Bay. Owing to the lateness of the maturation-period in the cold waters

of Puget Sound, we decided to go to Alaska as soon as possible and to stay there as long as favorable results could be expected. We looked forward to this trip with great expectations, for every one had spoken of the richness of the fauna in Sitka harbor, where the water is more shallow than in Puget Sound and from six to ten degrees warmer. Furthermore, through the kind agency of Captain Young, of the Marine Barracks at Sitka, Captain Symonds, of the warship 'Pinta,' had offered us the use of one of the Pinta's steam launches for dredging purposes. Everything, therefore, seemed more favorable for good collecting than at Port Townsend.

In the meantime the excursion to Port Orchard was planned and executed. Port Orchard lies across Puget Sound from Seattle and consists of several bays connected by deep channels of swiftly running water characteristic of this inland sea. In some of the pockets in these bays the tides are so little felt that the water is practically still and considerably warmer than the outer waters.

The swift water of the channels promised good dredging, but unfortunately we took with us our lightest dredge which was practically useless in the current; one fine brachiopod (*Terebratulina*) alone could hardly console us in our disappointment. The best results were obtained on shore, where Mr. Griffin found quantities of *Tychodera* (a genus of Enteropneusta), while hydroids of many kinds were as characteristic as their absence at Port Townsend. We left Port Orchard with the intention of returning in August, when, with a heavier dredge, we might expect better results.

The trip to Sitka offered few chances for zoological work. Happening to reach Fort Wrangle, however, at low tide, two of the party found a number of fine specimens of *Echiurus*, a form which we had not found in Puget Sound. On a previous trip to Alaska, Mr. Calkins had found a large number of ice worms (*Dendrobæna*) on the top of Muir Glacier. Although these interesting forms have been repeatedly described, this is the first time they had been found on the Alaska glaciers. They were most numerous in the clear water of pools in hollows of the ice, although in many cases they were found deeply imbedded in the solid ice, which had to be shaved down before the animals could be reached. This year the ascent of the glacier was not only extremely difficult, but, owing to the disappearance of the ice bridge, it was impossible to get on the top of the clear ice as last year. We accordingly found comparatively few ice worms.

We reached Sitka July 14th, with the loss of one package of collecting tools, which had been dropped overboard at Port Townsend during careless handling of the freight. These tools were fished out and sent to us by the next boat. A small house by the water was soon fitted with shelves and made into a somewhat cramped but convenient laboratory. We were much disappointed to find that the 'Pinta,' having been ordered south to the repair shops, had indeed left her steam launches, but with no one to run them. There was no other steam launch available, and all dredging, therefore, had to be abandoned, save such as could be ineffectually done with a sail boat. This deprivation was much more serious than any we had yet encountered, for we soon found that Sitka harbor itself is poorly adapted for good dredging, having an extremely rough, rocky bottom. The good dredging grounds, *i. e.*, bays with sandy bottoms, such as Silver Bay, Crab Bay, etc., were too far away to be reached by sail boat, although a launch could have made the round trip comfortably in one day. We were thus forced to confine our attention to low-water collecting. In this we were very successful. The tides ran out for a considerable distance, leaving

great stretches of rock and sand exposed. The most striking thing in regard to these rocks was the richness of many-hued sponges, of Bryozoa covering rocks and weeds with fleshy or encrusting colonies; while under the rocks, in addition to the usual crabs, star-fish and annelids, rarer forms of nemerteans, echiurids and sipunculids were frequently found. The small patches of sand and shell between the rocks contained quantities of gigantic *Nepthys*, *Amphitrite*, *Synapta* and sand anemones, while in certain regions groups of *Edwardsia*, lamellibranchs and various annelids might be dug up.

On the numerous rocky islands which abound in Sitka harbor we found great numbers of sea urchins, the large *Sphærechinus* in particular, which were neatly dissected for us by the noisy ravens whenever left in the tide pools. Here, too, were found many kinds of actinians, *Thysanurans* in abundance, and various hydroids. Under the wharf and on the piles were great forests of campanularian hydroids ensnaring quantities of copepods, nematodes, nudibranch molluscs and infusoria; while on them, as parasites, gigantic acinetans were abundant. Smaller single hydroids living on mollusc shells and on the piles were added to our collections, while an occasional holothurian (*H. Californica*) might be fished out with a long pole. Professor Wilson and Mr. Harrington found this echinoderm in great abundance on a sandy bottom at Redoubt, some twelve miles from Sitka, and in them an occasional *Entoconcha*.

The rocks under the wharf were carpeted with a thick velvet of Bryozoa, chiefly *Alcyonidiidæ*, *Cellulariidæ* and *Diastoporidæ*, and many different genera were well represented. Medusæ were abundant near the shores among the eel grasses and kelp. These were chiefly anthomedusæ and leptomedusæ, although *Haliclystus*, of the order stauromedusæ was occasionally found. The 'Elbowed' medusa described by Agassiz was especially abundant, while *Polyorchis cœruleus*, scyphomedusæ and several different species of *Thaumantias* were less numerous. Large specimens of *Salpa* sometimes drifted in from the Pacific, but ascidians were less numerous than at Port Townsend.

One of the most attractive methods of collecting at Sitka was by skimming; here, at high water, the tow was wonderfully rich, a single pipette full of the sediment from one tow was found to contain quantities of pteropod larvæ, the *Mitraria* larva of Metschnikoff, the *Actinotrocha* larva, *Polygordius* trochophores, a great species of *Appendicularia*, Pilidium larvæ, a pelagic rhabdocoel turbellarian, Auricularian and Bipinnarian larvæ, etc.

The collection and preservation of these interesting and often rare forms was not the only line of research. Cytological material for many different investigations was preserved. This included a series of maturation and fertilization stages of *Sphærechinus*, maturation and fertilization of *Edwardsia*, maturation material of *Thaumantias*, material for spermatogenesis of *Nepthys*, a full set of material for the development of medusa buds of *Plumularia*, maturation material of *Echiurus*, of *Holothuria*, maturation and fertilization of eggs of a lamellibranch, growth and embryological material of a tunicate, etc. In addition to this, notes were kept on the distribution of forms on rocks, piles or pelagic, and of course many notes on the habits, appearance and movements of the living animals.

Taking all into consideration, however, we are forced to the conclusion that, for shore collecting at least, Sitka is less favored than Port Townsend, where the great stretches of tide flats, shaded by long lines of wharves with innumerable piles, offer advantages for shore collecting hardly to be

surpassed. What our impression of Sitka might have been had we had the use of a launch for dredging can only be inferred; from the nature of the littoral fauna and from the pelagic forms it seems as though we might have found great richness at depths from five to twenty fathoms.

Owing to our limited resources for collecting at Sitka, and to the desire to get back to Puget Sound in time for embryological investigations, we decided to return to Port Townsend at the end of three weeks. Here we were met by an unforeseen difficulty. It was in the very midst of the tourist season, and in addition to the usual tourists many Christian Endeavorers had taken the opportunity to visit Alaska. The result was that the regular boats were overcrowded, and our only chance of getting away at the time desired was on some steamer coming north with miners and returning light. Such a chance was offered by the 'Mexico,' an extra boat put on to meet the rush to the Klondike. The 'Mexico' arrived at Sitka August 3d, after leaving about 300 miners at Skaguay and Dyea, and, as anticipated, she was practically empty for the return trip.

The captain of the 'Mexico,' who had lost time on the trip north, wanted to save time on the return trip, and decided to take the outside passage from Sitka, thereby saving sixteen hours on the usual time of the inside passage. It was the intention at first to enter the inside passage north of Mary Island, but later it was decided to run down to Dixon Entrance before leaving the open Pacific. We reached the entrance about midnight, but a light fog had settled, and for some hours the pilot caused the vessel to beat around at half speed or else to lie quiet. The water was too deep to anchor, and the effect of the strong currents on the vessel's course was not properly reckoned, for at four o'clock in the morning of August 5th the order was given to go ahead at full speed, and twenty minutes later the 'Mexico' crashed into West Devil Rock, a charted rock some distance (3–7 miles) out of the regular course. The hole made in the bottom of the vessel was beyond question of repair, and at 6.30 a. m. she sank out of sight in 500 feet of water.

After eighteen or twenty hours in the open boats the passengers were landed at the Indian village of New Metlahkatlah, where they were taken care of by the Indians and their chief, Father Duncan, until the 'Topeka' called for them, two days later, and carried them back to Puget Sound. Nothing was saved but the hand baggage; most of the instruments and all of our scientific material, reagents, notes, books and theses, representing not alone the summer's work, but unfortunately also much work of the previous year, now lie at the bottom of Dixon Entrance.

Without reagents and instruments and feeling more or less upset by the shock of the wreck, the entire party found it difficult to settle down again for work. A few dredging trips, however, enabled Mr. Harrington to renew his supply of *Entoconcha*, while turbellaria, molluscs and some cœlenterates were found in full maturity. The party soon broke up, and the material collected at Port Townsend and Port Orchard alone represents the work of the expedition of 1897. GARY N. CALKINS.

MIMICRY IN BUTTERFLIES OF THE GENUS HYPOLIMNAS AND ITS BEARING ON OLDER AND MORE RECENT THEORIES OF MIMICRY.*

THE theory of mimicry suggested by H. W. Bates, in 1862, explained the superficial resemblance of a rare to a common species in the same locality by supposing that the latter possessed some special means of defence (such as unpleasant taste, smell, etc.),

* Abstract of a paper presented by E. B. Poulton before the Section of Zoology of the American Association for the Advancement of Science.

and that the former, without the special defence, was mistaken by enemies for the latter, and thus escaped a considerable amount of persecution. The relation may be compared to that existing between a successful well-known firm and another small unscrupulous one which lives upon its reputation. On the other hand, Bates thoroughly recognized the existance of resemblances between the specially defended forms themselves. These he could not explain by his theory of mimicry, and suggested that they were a result of the influence of locality. Many years later Fritz Müller satisfactorily explained this difficulty by suggesting that a common type of appearance simplified the education of enemies and thus was the means of saving life. The lives of many individuals must be sacrificed before enemies have learned to recognize and to avoid the colors and patterns which indicate some special means of defence, and the fewer such patterns in any locality the smaller the sacrifice. The relation may be compared to that between two successful firms which combine to use a common advertisement.

This latter theory, although received rather coldly at first, has gradually made way, and seems now likely to occupy a good deal of the ground formerly believed to be covered by the former theory. Thus, Dr. F. A. Dixey, of Oxford, has recently shown that South American *Heliconinæ* are affected by the color of certain *Pierinæ* which have hitherto been looked upon as true Batesian mimics of the former.

The Old World Nymphaline genus *Hypolimnas* has been regarded as one of the best examples of mimicry, but an unbiased examination leads to the opinion that it affords a case of Müllerian rather than Batesian resemblance.

In India the female of the common species *H. bolina* resembles *Euplæa Core*, while the male is a dark butterfly with a large white spot shot with blue on each of the four wings. Throughout the Malay Archipelago representative species occur with males like that of *H. bolina* and females resembling the local *Euplœas*. Occasionally, as in Ké Island and the Solomons, species of the genus occur in which the male as well as the female resembles a *Euplœa*. In Fiji the male is as in the Indian species, while the female is extremely variable, ranging from forms like the male through intermediate varieties to brown and straw-colored individuals. The *Euplœas* of Fiji are not sufficiently known, but it is very improbable that all the forms of the female *Hypolimnas* are mimetic. A still more instructive case is that of the *nerina* form of female found, with a male like that of *H. bolina*, in Australia, Celebes, New Guinea and other East Indian islands and in many of the Polynesian groups. This conspicuous and abundant butterfly has, in addition to the four white-and-blue spots of the male, a large reddish brown patch upon each forewing. This well-marked form resembles no other butterfly except the *Danais chianippe* of Celebes, and, as this latter appears to be very rare, it is far more probable that the resemblance has come from the other side, and that the *Danais* has approached the *Hypolimnas*.

In Africa the subgenus *Euralia* is represented by several species which resemble in both sexes species of the Ethiopian Danaine genus *Amauris*.

Finally, there is a well-known and widespread *Hypolimnas misippus*, which accompanies *Limnas chrysippus* throughout its range; while the female of the former resembles the latter very closely. In this case it is certain that we have to do with no struggling, hard-pressed form, for the *Hypolimnas* has recently established itself in some of the West India Islands and in Demerara —localities in which its model, *L. chrysippus*, is as yet unknown.

To sum up, the genus *Hypolimnas* is distinguished among Nymphaline genera for the extent to which its numerous and widespread species resemble the local distasteful forms of Euplœinæ or Danainæ.

Upon the older theory of Bates this would be explained by supposing that the genus is very hard-pressed in the struggle, and has thus been driven to mimicry almost everywhere. Upon the newer Müllerian theory it is supposed that the genus is distinguished among Nymphaline genera by some special defense, probably in the way of taste or smell or indigestibility, and that it has been to its advantage to adopt the advertisement of still better known and probably still more distasteful forms in its locality.

The abundance of the various species, the conspicuous *nerina* form of female, and the resemblance of a rare Danaid to it, the recent spread of *H. misippus* beyond the limits of its model, all support this latter interpretation.

NOTES ON ENGINEERING.

THE cost of power in New England cotton mills has been, of late, the subject of some discussion in technical and lay journals. The lowest cost yet reported, with one exception, is that given by Mr. Sheldon for the case of a mill which, paying $1.76 per ton for coal, obtained the horse-power for a total cost per annum, including all items on the treasurer's books, interest, depreciation, taxes, etc., of $11.64.

This figure was challenged and compared with the items generally given for other classes of engine which are usually two or three times as great and often much more. But the latest report comes from the Warren Steam Cotton Mill, where an engine of 1,950 horse-power, a cross-compound condensing machine, with cylinders 32 and 68 inches diameter and of five-feet stroke of piston, making 74 revolutions per minute, steam at 155 pounds at the boiler, supplies power at the cost of 1.35 pounds of coal per horse-power hour. The engine was designed by Edwin Reynolds, the boilers built by the Heine Company. The following are the figures certified to Dr. Thurston by the treasurer of the mill. The engine replaces a quadruple-expansion engine, destroyed by fire, after seven years of excellent service. The change illustrates the fact that the cost of the higher grade of machine may more than compensate its exceptional economy; a fact which has only in late years come to be recognized.

In the following table of the costs of the new engine the figures come from the treasurer's books. Coal costs $2.26 per ton, and in the account includes all costs of all steam used for all purposes, including banked fires, nights and Sundays, and that supplied the mill.

The following is a tabulated statement of the cost of power:

Fuel per horse-power per year of 3,070 hours	$ 4 70
Labor	1 88
Supplies and repairs	42
Total operating expenses	$ 7 00
Interest at 5 per cent	$ 2 05
Depreciation, at 5 per cent	2 05
Taxes	41
Insurance	04
Fixed charges	$ 4 55
Totals cost of power per year	$11 55

According to the Providence (R. I.) *Journal:* "This is lower than anything yet found. It is due to the large size of plant, which reduces the labor and supply account per horse-power, and to low cost of fuel and insurance and low cost of plant, on account of its size. The cost of plant includes a Green economizer, chimney, boiler-house, engine-house and foundations—all first class—and water-tube boilers, whose depreciation ought not to be over 2½ per cent. If steam used for other purposes than power were deducted, it would reduce the fuel 10 per

cent., or 47 cents per year, per horse-power, making the total $11.08. There is no way of separating this amount from the total in the regular accounts."

So far as known, this is the lowest cost of steam-power in any New England textile mill. The tons fuel per horse-power per year is 2.08—the lowest noted; others run about 2.20 tons per horse-power and upward.

R. H. T.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR MICHAEL FOSTER will deliver several lectures in Baltimore in October and will visit Boston later to deliver a course of lectures at the Lowell Institute.

PROFESSOR JAMES E. KEELER, of the Allegheny Observatory, has accepted an invitation to make the dedicatory address at the opening of the Yerkes Observatory.

DR. FRIDJOF NANSEN is expected to arrive in New York on the steamer St. Paul, on October 23d. After visiting Washington as the guest of the National Geographic Society, he will give his first lecture in Carnegie Hall, New York, on October 28th. At the close of the lecture a medal will be presented to him by the American Geographical Society. The collections now at Stockholm will be brought to America and exhibited here.

SIR WILLIAM TURNER, President of the Anthropological Section, of the British Association for the Toronto meeting sailed from Montreal on the 22d. He will in future devote his time less to histological and more to anthropological researches.

WE regret to notice the death of Dr. Holmgren, since 1864 professor of physiology in the University of Upsala, at the age of sixty-six years.

THE following deaths are also announced: Dr. August Mojsisovics Edler v. Mojsvar, professor of zoology in the Polytecnic Institute at Graz; Mr. William Archer, F.R.S., librarian of the National Library of Ireland; Dr. T. Bogomoloff, professor of medical chemistry in the University of Kharkoff; Dr. John Braxton Hicks, F.R.S., one of the pioneers of British work on diseases of women, and a Fellow of the Royal Society since 1862.

THE British Association, at the recent Toronto meeting, granted £1,350 for scientific research. We hope to give next week details of the appropriations.

THE French Academy has accepted a legacy from M. Pierre Lassere amounting to over $100,000; the income from one-third of this sum is to be awarded by the Academy of Sciences for a scientific discovery.

A SMALL fund, founded in memory of Surgeon-Major Arthur Barclay, is to be used for a bronze medal to be awarded every third year by the Asiatic Society of Bengal for the most meritorious piece of work done in original research in biology, with special reference to India.

A BRONZE monument, erected in honor of Marcello Malpighi, the eminent Italian anatomist and botanist of the seventeenth century, was unveiled at Crevacore, near Bologna, on September 8th.

THE new museum of the Brooklyn Institute of Arts and Sciences will be dedicated on October 2d. Addresses will be made by President Eliot, of Harvard University, and by Mayor Wurster, of Brooklyn. There will be a reception in the evening in the Academy of Music.

IT is reported that plans have already been made for the new building of the American Geographical Society, New York, although the site has not yet been decided upon. The present building in West 29th street, purchased in 1875, has long been outgrown by the Society, and it has assets amounting to nearly $400,000. The Society owes its present position and great growth to Judge Daly, who for thirty-three years has been its President.

THE Greek Archæological Society has secured possession of a quarter of Athens lying immediately under the Acropolis. The inhabitants will remove to the suburbs, and excavations promising important discoveries will begin shortly.

A SERIES of seven kites of the Hargrave type, sent up from the Blue Hill Observatory on Sep-

tember 19th, reached a height of 9,386 feet above the summit of the hill, this being the highest ascension thus far made. The kites carried an aluminium box with instruments for recording temperature, pressure and humidity, and the records are a further demonstration that kites may become a valuable addition to the methods of meteorology.

A MICROTOME for making sections of the entire human brain is being constructed by Messrs. Bausch and Lomb on the pattern of the 'automatic precision microtome,' recently described in our pages. The manufacturers expect that the new instrument will make large sections of greater thinness and accuracy than it has been possible to obtain hitherto.

THE *Atlantic Monthly*, 'devoted to literature, science, art and politics,' has completed its fortieth year with the current number and publishes an editorial retrospect eight pages in length. Its scientific work is thus described: "In 1862 scientific articles by Agassiz began to appear, and a long succession of his writings was brought to an end by a paper published in 1874, just after his death. Even if the *Atlantic* had done nothing else in the field of science this record would be worth making; but the great achievements of these later years have always formed an important part of its contents, and have been related by men like Rodolfo Lanciani, Percival Lowell, N. S. Shaler, G. F. Wright and T. J. J. See, who has a notable article in the present number." Compared with the men of letters mentioned by the *Atlantic Monthly* this list indicates that its devotion to literature has exceeded its devotion to science.

THE New York State Library Association, at its meeting in 1896, recommended the fifty books of 1895, regarded as best for a village library. The scientific books included are as follows: Edward Clodd, 'Story of primitive man;' Percival Lowell, 'Mars;' S. H. Scudder, 'Frail children of the air;' M. O. Wright, 'Birdcraft;' Philip Atkinson, 'Electricity for everybody.'

THE University of the State of New York has published the report of the Public Libraries Division for 1896, which gives a complete and interesting survey of the growth of libraries in the State. 806 libraries of 300 volumes or more have sent in reports. These libraries contain a total of 4,647,661 volumes, of which number 296,498 were added during the year. The libraries in the State having over 100,000 volumes are as follows:

New York, N. Y., Public Library, Astor, Lenox and Tilden foundations 367,808; New York, Mercantile Library, 253,783; Albany, New York State Library, 223,547; New York, Columbia University Library, 223,000; Ithaca, Cornell University Library, 186,683; Brooklyn, Brooklyn Library, 124,-299; New York, General Society Mechanics and Tradesmen Library, 106,440.

The libraries that added over 10,000 books during 1896 are as follows:

Columbia College Library, 20,580; New York Public Library, 15,594; New York State Library, 14,570; Cornell University Library, 13,578; New York Free Circulating Library, 11,201.

THE Minnesota Child Study Association, organized in 1895, has published a hand-book of 60 pages, which may be secured for 30 cents from the Secretary of the Association, Mr. E. A. Kirkpatrick, Winona, Minn. The pamphlet contains a number of suggestions and syllabi for the study of children, which will prove useful, more especially in view of the lack of a systematic treatise on the subject.

IN a letter, lately published, from Mr. Voorhes, Vice-President, to Mr. Charles H. Fahl, the engineer of the train, the former gives the figures for the runs of the train between Camden and Atlantic City last season, and gives deserved credit to the engineer. The facts are most remarkable and creditable, and the action of the Vice-President of the road is commendable in a remarkable degree. Were it an ocean steamer of which the performance was thus described the credit would have been given solely, in the usual case at least, to the commanding officer; the engineer would have been forgotten. Mr. Voorhes says: "The train record shows that for the fifty-two days the train ran, from July 2d to August 31st, the average time consumed on the run was forty-eight minutes, equivalent to a uniform rate of speed, from start to stop, of sixty-nine miles an

hour." * * * "This performance, I believe, has not been equaled in the history of railway service, either in this country or abroad. It is one of which the management is proud, and is accredited to the track, the equipment, and, especially, to the skill with which you performed the task entrusted to you." The distance was fifty-five and a-half miles, and the train consisted of five or six cars. It was always delayed by its connections at starting, and always came in ahead of schedule time; the total thus being brought four minutes under schedule time. The thanks of the railway officials are tendered Mr. Fahl.

THE Congrès Olympique recently held at Havre has passed resolutions summarized in the *British Medical Journal* as follows: Every three months parents are to be informed of the physical development of their children being educated in schools and colleges. That hygiene, physical training and athletic sports should be introduced in all schools, *lycées* and colleges. In all schools, colleges and *lycées* a service of hydrotherapy should be in working order. That a diploma for gymnastics be created, requiring a practical and oral examination.

THE Eleventh International Congress of Orientalists has held a successful meeting in Paris, many important archæological papers having been presented and plans having been made for further explorations in the East.

THE Council of the Society of Arts have appointed the following Committee to investigate the causes of the deterioration of paper: Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Chairman of the Council; Sir William Anderson, K.C.B., F.R.S.; Mr. Michael Carteighe; Mr. C. F. Cross; Sir John Evans, K.C.B., F.R.S.; Dr. Richard Garnett, C.B.; Dr. Hugo Müller, F.R.S.; Dr. J. W. Russell, F.R.S.; Mr. W. L. Thomas; Professor J. M. Thomson, F.R.S.; Mr. Henry R. Tedder; Dr. Quirin Wirtz; Sir Henry Trueman Wood, Secretary. *Nature* states that, in the course of a circular letter which has been sent to those who are interested in the preservation of paper, it is pointed out that many books of an important character are now printed upon paper of a very perishable nature, so that there is considerable risk of the deterioration and even destruction of such books within a limited space of time. This is believed to be especially true of books which are in constant use for purposes of reference, and are therefore liable to much handling.

ACCORDING to the New York *Tribune* the most interesting work now going on at the Weather Bureau is the preparation of an exhibit of this Bureau for the Paris exhibition in 1900. Professor Moore is taking a deep interest in the matter, and, as planned, it will be one of the largest and most complete expositions of this character ever made. A feature of the exhibit will be a daily weather chart of the United States. A code has been adopted by which the conditions of the weather in all parts of the United States will be transmitted by telegraph to Paris. From the material thus obtained maps will be constructed on the order of those now in general use. Professor Moore, with five or six of his subordinates, will represent the Weather Bureau at the exposition, and nothing is being left undone to make a showing worthy of the United States Bureau, which is acknowledged by scientific authorities to be the finest in the world.

LIEUTENANT PEARY, on arriving at Philadelphia, is reported to have said that in addition to securing the meteorite he laid the plans for next year's expedition, and when he leaves again, which will be about the end of next July, it will be to remain in the Arctic regions until he reach the Pole or lose his life in the attempt, even if it take five years to accomplish this object. Next summer he will take his vessel up to Sherard Osborne Fjord and make that place his base of supplies. On the last trip he made arrangements with the Arctic Highlanders, a tribe of Esquimaux consisting of 230 men, women and children, known as the most northerly tribe of human beings on the earth, to spend this coming winter in obtaining bear, seal and deer skins for clothing and in securing all the walrus meat they can for dog food. He has singled out eight young men of the tribe, with their wives, canoes, dogs, sledges and tents, to accompany him to Sherard Osborne

Fjord, which is about three hundred miles further north than their present abode. The party will consist of a surgeon, possibly another white man and Lieut. Peary; the rest will be Esquimaux. The latter know how to drive dogs; they can go hungry and know how to get food. The conditions under which he will make the coming expedition are of the most satisfactory character. The American Geographical Society has assured $150,000 to meet all expenses. Lieutenant Peary has five years' leave of absence. He will probably buy a new ship for next year, though he may possibly use the Hope again.

UNIVERSITY AND EDUCATIONAL NEWS.

INSTITUTIONS FOR HIGHER EDUCATION IN THE UNITED STATES.

THE report of the Commissioner of Education for the year 1895–6 reports that the total number of universities and colleges for men and for both sexes reporting during the year was 484, of which number 345 admit women to undergraduate courses of study. There are 188 institutions which have not as yet any endowment; 54 have endowment funds less than $25,000, and only 4 institutions have endowments exceeding $5,000,000. In a large number of the institutions a comparatively small part of the work is collegiate. There are at present 278 institutions having less than 100 students in undergraduate collegiate courses. The number of instructors reported by the 484 institutions was 12,277, while the number of students of all classes, secondary and higher, was 159,372. Of the latter number 47,014 were in preparatory departments, 68,629 in collegiate departments, 4,673 in graduate departments and 25,438 in professional departments. The property reported was as follows: Volumes in libraries, 6,453,677; value of material equipment, $134,093,435; endowment funds, $109,562,433. The benefactions for the year, so far as reported, amounted to $8,342,728, and the income, excluding benefactions, was $17,918,174.

The 162 colleges for women had, in 1894–'95, 2,552 instructors and 24,663 students. The material equipment was valued at $15,568,508, and the endowment funds amounted to $5,308,558. The income was $3,456,983, and the benefactions received during the year amounted to $611,245.

The number of schools of technology, excluding technological departments of universities and colleges, was 48, having 1,118 instructors and 12,816 students. The total value of all property was reported at $24,105,242, of which amount $10,384,293 was reported as endowment funds. The income of these institutions was $3,526,018, of which amount $2,402,332 was appropriated by the General and State governments. The gifts and bequests received by the schools of technology amounted to but $96,133.

The increase in attendance at these universities and colleges is shown in the accompanying figure:

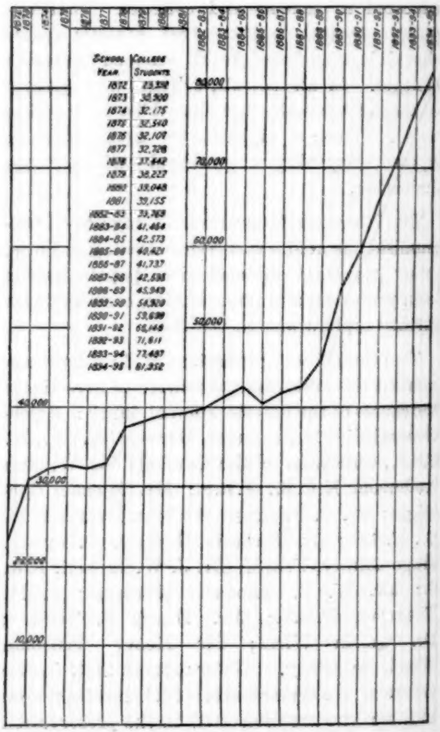

FIG. 1. The increase in attendance at American universities and colleges from 1872 to 1894–5.

GENERAL.

It is reported that Harvard College and the Massachusetts Institute of Technology will each receive about $500,000 from the estate of the late Henry O. Pierce, under whose will they are, together with three other institutions, the residuary legatees. The amount to be divided has proved much larger than had been anticipated. The value of these bequests is much increased by the fact that they are unaccompanied by restrictions.

The will of the late Eliza W. S. P. Field gives $80,000 to the University of Pennsylvania, and makes the University residuary legatee of her estate.

Mrs. Esther B. Steele, of Elmira, N. Y., has given $5,000 towards the cost of a physical laboratory for Syracuse University. The building, which will cost about $25,000, will be erected shortly.

Furman University, at Greenville, S. C., has been given by Dr. and Mrs. F. A. Miles real estate valued at $20,000.

The will of Theodore Lyman, whose death we were recently compelled to record, bequeathes $10,000 to Harvard University and a collection of valuable books to the Museum of Comparative Zoology.

Ex-Governor Flower has given $5,000 to Cornell University for the purpose of a library for the Veterinary College.

The will of the late Henry W. Sage, lately President of the Board of Trustees of Cornell University, to which institution he had given about $1,250,000, disposes of property worth $12,000,000, but makes no public bequests.

Dr. Elisha Gregory, Jr., formerly demonstrator of anatomy at the University of St. Louis, has returned, after a year's study in Germany, to enter upon his duties as instructor in histology and embryology at the Harvard Medical School.

Professor Peter T. Austen has left the department chemistry at the Polytechnic Institute, Brooklyn, and is succeeded by Professor Fay.

Mr. C. H. Benedict has been appointed instructor and Mr. J. M. Talmage assistant in chemistry in Cornell University.

At a meeting of the regents of the University of the State of California the resignation of Professor Colton from the staff of the Lick Observatory was accepted.

The following appointments have been recently made: Dr. Weiss, professor of mathematics in the Institute of Technology at Prague; Dr. Herzig, associate professor of chemistry in the University of Vienna; Dr. Zelinka, of Graz, professor of zoology in the University at Czernowitz; Dr. Zwaardemarker, professor of physiology in the University of Utrecht; Dr. Julius Hann, director of the Vienna College of Meteorology, professor of meteorology at Graz, in Styria; Professor Joseph Pernter, professor of cosmical physics in Innsbruck University, appointed to the vacancy caused by Dr. Hann's retirement from the Vienna College; Dr. W. Ernest Thomson, professor of anatomy in Anderson College, Glasgow, and M. Brunhes, professor of physics in the faculty of science at Dijon.

The Cambridge University Calendar shows that the undergraduates in residence at the University now number 2,928, of whom 664 are members of Trinity College and 264 of St. John's.

The *Athenæum* says that a proposal is being considered to establish at Swansea, as a great manufacturing center, a branch University College in association with either Aberystwith or Cardiff, as the Newcastle College is associated with Durham. The suggestion is that scientific and technical courses might be taken at Swansea in preparation for the Welsh University degree.

DISCUSSION AND CORRESPONDENCE.

METEOROLOGY IN SOUTH AMERICA.

To the Editor of Science: During the writer's present trip down the eastern coast of South America, he has gathered a few facts regarding meteorological work on this continent which may interest the readers of Science.

The only complete meteorological service in

South America is that of the Argentine Republic, with headquarters at Cordoba. The Argentine meteorological office, established by the late Dr. B. A. Gould, has, since the date of Dr. Gould's resignation as its director (1883), been under the direction of Mr. W. G. Davis. This service has at the present time nine first-order stations, fifty-eight second-order and one hundred and twenty-six third order. Of the first order stations, the most interesting in many respects, is that on the Isla de los Estados (Staten Island), off the southeastern extremity of South America, where the meteorological conditions present many unusual features. In addition, Mr. Davis will soon have in operation six new mountain stations, reaching from Patagonia along the Cordilleras into northern Argentina. These new stations will, in connection with the Harvard meteorological stations in Peru, form a splendid series along the western coast of South America.

As yet the Argentine meteorological service makes no attempt to publish a daily weather map or to issue forecasts, the director believing that his first duty is to establish and equip his stations, and to study the general climatological features of the region. *The Anales de la Oficina Meteorologica Argentina* already number nine large volumes, containing meteorological data as to the climate of Argentina. Vols. X. and XI. are now in press, and contain, among other data, the observations made on the Isla de los Estados, and a discussion of them. In addition to the ordinary work directly connected with the weather service, the director has made studies of the climatic conditions of different parts of the country as bearing on the raising of various crops, on the manufacture of cotton, etc., and of the relation between atmospheric conditions and disease in Buenos Ayres and Cordoba. The physiological effects of different weather types have also been studied. The forthcoming census of Argentina will contain chapters on the climatology of the country, illustrated by charts, also the work of the director. The observers of the Argentine meterological service now receive ten dollars (paper) a month for their services, and it is the policy of the director to do all he can to keep them interested in their work and to secure as accurate observations as possible from them. He accomplishes this by constant personal correspondence with the individual observers, and by sending them such meteorological books as they may wish to see and which he is able to loan them. At present, for instance, he is sending out eighty copies of the new cloud atlas to the observers. Such a policy is worthy of adoption by other weather services.

In 1882 the capital of the province of Buenos Ayres was removed from Buenos Ayres to the new city of La Plata, in Latitude 34° 55′ S., Longitude 57° 54′ W. Here an observatory was built for carrying on astronomical, magnetic and meteorological work, and a provincial weather service has been organized under the direction of V. Bœuf. The headquarters are at La Plata, and there are at present some sixty stations in all. Sixteen of these take the ordinary observations at 8 a. m. and 8 p. m., and report by telegraph to La Plata every morning, while the remaining (pluviometer) stations report wind direction, cloudiness and rainfall. The La Plata Observatory publishes a daily weather map, based on these data, and this is the only map of the kind at present issued in South America. This is no forecast, and the map relates solely to the province of Buenos Ayres, and not to the republic as a whole. The chief office has a poor instrumental equipment, there being, at the time of the writer's visit, no self-recording instruments in operation. Cloudiness is estimated in quarters of the sky covered, instead of in tenths, as is usually the case. Hourly observations are made at La Plata every hour from 6 a. m. to 8 p. m.

At Rio de Janeiro meteorological observations are regularly made at the National Observatory, situated on the most easterly hill of the city, overlooking the harbor. The instrumental equipment is good, and observations are made eight times in every twenty-four hours (1, 4, 7 and 10 a. m. and p. m.). The observatory is under the direction of L. Cruls, who also has charge of the geographical and geodetic work of the republic. The meteorological observations have been published in various volumes of the *Annales de l'Observatoire*. M. Cruls has lately been the chief of a commission appointed

to inquire into and report upon the availability of a new site for the national capital. According to the Federal Constitution the capital must be removed from Rio de Janeiro to a more healthy location in the interior province of La Goyaz, at a considerable altitude above sea level. The above-mentioned commission has published an elaborate report, finely illustrated with photographs and charts, in which the geology, hydrography, climatology, etc., of the new site receive consideration. The work is a very interesting one.

Owing to the unfavorable atmospheric conditions at Rio, where the cloudiness is very considerable, there has for some years been a plan to remove the Observatory to a new location near Petropolis, in the Organ mountains, at an altitude of over 2,700 feet. Petropolis is a place much sought by the wealthier classes of Rio during the summer months, when yellow fever is most prevalent in the capital. It is high enough to be above the yellow fever zone, and its cool evenings and nights are much more agreeable than the hot nights of Rio. Furthermore, it is above the fogs which commonly hang over Rio harbor at night, and is therefore a much more favorable location for an astronomical observatory. The necessary funds for the removal are, however, lacking, and there is at present no prospect that the location of the Observatory will be changed.

There is a very common belief that the *climate* of Rio is unhealthy. This is by no means the case. The climate itself is a fine one in many ways, the unhealthy character of the city being due simply to the lack of attention to the simplest sanitary measures. Rio harbor itself, beautiful as it is, is the most deadly feature about the whole place. The waters are so foul, as a result of the improper disposal of the city's sewerage, that they are a veritable storehouse of disease. When the city adopts proper sanitary regulations and builds sewers to empty its drainage into the open ocean, instead of into the harbor, then Rio will become as healthy as a city with its beautiful situation deserves to be.

This letter is mailed in the Falkland Islands. Although the meteorology of these islands is most interesting, regular observations are no longer made here. Those made here in the past have been discussed by Marriott (Quart. Jour. Roy. Met. Soc., London, 1880), and by von Dankelmann (Ann. d. Hydrog, Berlin, 1885). Mr. Davis, of the Argentine meteorological office, has sent two sets of instruments to the islands, but has not yet succeeded in securing regular observers. The climate of the islands is particularly interesting by reason of their far southerly position in the stormy prevailing westerlies of the southern hemisphere. Sunshine is so rare here in winter that, as an old resident of Port Stanley said to the writer to-day, "When we see the sun for an hour or two everyone says 'what fine weather we are having.'"

R. DeC. Ward.

Port Stanley, Falkland Islands, July 29, 1897.

SCIENTIFIC LITERATURE.

Memoirs of the American Folk-Lore Society. Vol. V., 1897. Navaho Legends, Collected and Translated by Washington Matthews, M.D., LL.D. With Introduction, Notes, Illustrations, Texts, Interlinear Translations, and Melodies. Boston and New York, Houghton, Mifflin and Company. Pp. 299.

A study of aboriginal life from the pen of Dr. Washington Matthews is always welcome, and this volume of Navaho Legends is no exception to the pleasant rule. Out of the abundant material collected by the author he has selected three legends for this publication: two incomplete rite-myths and the Navaho Origin Legend. The latter 'divides itself into four very distinct parts,' I. The Story of the Emergence; II. Early events in the Fifth World; III. The War Gods; and IV. The Growth of the Navaho Nation. The term rite-myth is defined as 'a myth which accounts for the work of a ceremony, for its origin, for its introduction among the Navahoes, or for all these things.'

The Navahoes, we are told, "celebrate long and costly ceremonies, many of which are of nine days' duration. Each ceremony has connected with it one or more myths, or legends which may not be altogether mythical." These rite-myths possess a degree of traditional value, and the last chapter of the Origin legend, our author says, 'is in part traditional or historical, and is even approximately correct in many of

its dates.' This group of legends, therefore, belongs to a class, the knowledge of which is indispensable to a reconstruction of the past life of a tribe, or to the understanding of existing conditions of the people, or to the tracing of the contact and interrelations of tribes prior to the historic period of this continent.

The introduction, and more particularly the voluminous notes, in the preparation of which the author had in mind their 'interest to the ethnographer,' are replete with information. They explain, more or less in detail, customs mentioned incidentally in the legends, and cite the evidence by which localities referred to in the text have been identified. They also contain extracts from varients of the legends, and note other rites and myths in which figure the divinities of the narrative, and give numerous linguistic and other explanations of names, rites, customs, etc., which put the reader in possession of knowledge invaluable for the study of these Indians. The breadth of view of the subject treated is enlarged by abundant cross references, both to matter within the volume and to other writings of the author upon the Navahoes, a complete list of which is included in the Bibliographic Notes compiled by Mr. F. W. Hodge, forming a part of the book.

In presenting these legends to the public the author has "not confined himself to a close literal translation. Such translation would often be difficult to understand, and, more often still, be uninteresting reading. * * * The tales were told in fluent Navaho, easy of comprehension, and of such literary perfection as to hold the hearer's attention. They should be translated into English of a similar character, even if words have to be added to make the sense clear. * * * If he has erred in rendering the spirit of the savage authors, it has been by diminishing rather than by exaggerating. * * * In order that the reader may judge how closely the liberal translation here offered follows the original, the Navaho text of the opening passages—ten paragraphs—of the Origin legend, with interlinear translations, are given in the notes."

Fifteen pages or more of these interlinear translations afford an opportunity to observe the construction of the language and its use in narrative, ritual and song.

The examples of Navaho songs are interesting, not only in relation to the legends and the use of the language with poetic intent, but because they show that the same device obtains among the Navahoes which is common with the Indians of the Siouan linguistic group, a device to produce the effect of rhyme by means of certain 'meaningless vocables' at the close of each sentence. In his introduction, Dr. Matthews calls attention to the use of archaic words in the songs, to which 'the priests assign traditional meanings;' and also to the 'numerous meaningless vocables in all songs,' which 'must be recited with a care at least equal to that bestowed on the rest of the composition.' The same precision is required in the repetition of the vocables in the songs of the Siouan group. The writer having discovered that the emotional prompting of the song decides the choice of these vocables, it is especially interesting to note that, making allowance for the wide difference of language, the vocables given in the Navaho songs seem to follow the same rule that appears to govern their use among the northern tribes.

The short essay by Professor John Comfort Fillmore, upon the music—included in the notes—is of peculiar interest. His extended experience with Indian songs, added to his scholarly attainments in music, makes whatever he has to say upon this subject worthy the careful consideration of those interested in this phase of ethnological research. To quote from Professor Fillmore, Note 272, speaking of the songs transcribed from the phonographic records taken by Dr. Matthews, "they have very great scientific interest and value, inasmuch as they throw much light on the problem of the form spontaneously assumed by natural folk songs. Primitive man, expressing his emotions—especially strongly excited feeling—in song, without any rules or theories, must, of course, move spontaneously along the line of least resistance. This is the law under which folk-melodies must necessarily be shaped. The farther back we can get toward absolutely primitive expression of emotion in song, the more valuable is our material for scientific

purposes; because we can be certain that it is both spontaneous and original, unaffected by contact with civilized music and by any and all theories. In such music we may study the operation of natural psychical laws correlated with physical laws, working freely and coming to spontaneous expression through the vocal apparatus.

"These Navaho songs are especially valuable because they carry us well back toward the beginnings of music making. One only needs to hear them sung, or listen to them in the admirable phonographic records of Dr. Matthews, to be convinced of this from the very quality of tone in which they are sung. In all of them the sounds resemble howling more than singing, yet they are unmistakably musical in two very important particulars: (1) In their strongly marked rhythm. (2) In the unquestionably harmonic relations of the successive tones."

The limits of this article forbid following Professor Fillmore in his treatment of these two particular points, Rhythm and Harmonic melody, or to recount the evidence leading to his conclusion 'that the harmonic sense is the shaping, formative principle in folk melody.'

Of the many interesting points brought forward in this volume, only one or two can be indicated, and these are selected not so much to give the scope of the volume as to illustrate its wealth of suggestion.

In accounting for the limited number of arts practiced by the Navahoes, the author says: "In developing their blanket making to the highest point of Indian art, the women of this tribe have neglected other labors. The much ruder but allied Apaches, who know nothing of weaving woolen fabrics, make more baskets than the Navahoes, and make them in much greater variety of form, color and quality. The Navahoes buy most of their baskets and wicker water jars from other tribes. They would possibly lose the art of basketry altogether if they did not require certain kinds to be used in the rites, and only women of the tribe understand the special requirements of the rites." It would seem that special proficiency in the manufacture of some one article, while it may limit the development along other lines, leads to trade and the peaceful intercourse between different peoples.

In introducing the subject of poetry and music the author calls attention to the fact that for many years the most trusted account of the Navaho Indians was to be found in a letter published in the Smithsonian Report for 1855. The writer had lived three years in the heart of the Navaho country, and was aided in preparing this letter by an officer in the United States Army who had long commanded a post in the vicinity, both being men of unusual ability. From this letter the following statement is taken: "Of their religion little or nothing is known, as, indeed, all inquiries tend to show that they have none. 'The lack of tradition is a source of surprise. They have no knowledge of their origin or of the history of the tribe.' 'They have frequent gatherings for dancings.' 'Their singing is but a succession of grunts, and is anything but agreeable.' In spite of the evidence of these gentlemen, fifteen years ago when the author first found himself among the Navahoes he was not influenced in the least by the authority of this letter. He had not been many weeks with these Indians when he discovered that the dances referred to were religious ceremonials, vying 'in allegory, symbolism, and intricacy of ritual with the ceremonies of any people, ancient or modern.' The 'succession of grunts' reveal 'that besides improvised songs, in which the Navahoes are adepts, they have knowledge of thousands of significant songs—poems, as they might be called—which have been composed with care and handed down, for centuries perhaps, from teacher to pupil, from father to son, as a precious heritage, through the wide Navaho nation.'"

The author's rich gleaning in a field pronounced barren can be repeated elsewhere in the land, but, to achieve results like his, similar equipment is necessary. It is not enough, as the incident just quoted shows, 'to live in the vicinity' of a people; to report accurately upon them, one must have come so near to them and in such manner as to draw from willing lips their tribal lore.

It would be unjust to Dr. Matthews's work, and to the lesson it contains for us, not to call attention to the characteristic which is an important factor in making him a trustworthy authority in any field where he has studied,

his hearty recognition of the claims of a common humanity. This recognition makes him appreciate the seriousness of interpreting the men of one race to men of another race, and begets a fairness of presentation that lifts his work to a high standard of truthfulness. His manly conscientiousness is evident throughout the book in the choice of words, in the turn of a sentence, in the "testimony in favor of the Shamans, and the incidents related of Tall Chanter, Torlino and others; it is also noticeable in the illustrations of the book, particularly in the portraits, which, while characteristic, are without the brutal exaggerations of feature so painfully common in Indian pictures. While this may be regarded as the personal equation of the author, it nevertheless indicates certain qualities, the presence or absence of which in a field investigator helps or mars his work."

The contributions to ethnology offered in this volume are particularly timely, for the questions, "How have the tribes of North America been built up?" and "what have been the directive influences in determining their arts, cults and organization?" are of increasing importance, as the study of our native peoples passes beyond the initial stage. The student is under great obligations to the author for the perspicuous presentation of his material, due to his grasp of the subject, power of classification and concise statement, and his ability to rigorously exclude extraneous matter.

The excellent workmanship of the book—the type and illustrations, three being in colors—is worthy of the publishers, and reflects credit upon the Folk-Lore Society.

ALICE C. FLETCHER.

BOTANY OF THE AZORES.*

SINCE the publication of Hewett C. Watson's chapters on botany in Godman's Natural History of the Azores, published nearly thirty years ago, no important contributions have been made to the botany of this group of oceanic islands. The present paper, based on two summers spent in the islands, is a catalogue of all of the plants, cryptogamic as well as phanerogamic, heretofore recorded as Azorean, with a reasonable attempt at the exclusion of synonyms, especially in the higher groups. While in the phanerogams comparatively few species have been added to those previously recorded, the distribution by islands is indicated much more fully than ever before, and the list of Thallophytes very considerably increased. It is stated that, although the list of flowering plants and ferns is believed to be nearly complete, and perhaps relatively few additions to the lichens will be made, the fungi are still practically unstudied, and the algal flora, especially that of the wet sphagnum with which the highlands are usually covered, is likely to be very greatly increased by careful study. In the catalogue a reference is given, under each species, to places in which it has previously been mentioned as Azorean, and an adequate description and plate are cited. Where the latter has not been practicable, the species has been figured. In connection with this paper should also be noted Cardot's recent paper on the mosses of the Azores and of Madeira, previously mentioned in these columns.

* Botanical Observations on the Azores. By William Trelease. From the Eighth Annual Report of the Missouri Botanical Garden, St. Louis, Mo. Issued September 9, 1897. 8vo, pp. 144, frontispiece and 55 plates.

NEW BOOKS.

The Dawn of Astronomy. J. NORMAN LOCKYER. New York and London, The Macmillan Company. 1897. Pp. xvi. + 432. $3.00.

The History of Mankind. FRIEDRICH RATZEL; translated by A. J. BUTLER. London and New York, The Macmillan Company. 1897. Vol. II. Pp. xiv. + 562. $4.00.

Traite elémentaire de mécanique chimique. P. DUHEN. Paris, A. Hermann. 1898. Vol. II. Pp. 378.

Wild Neighbors. ERNEST INGERSOLL. New York and London, The Macmillan Company. 1897. Pp. xii. + 301. $1.50.

Deductive Physics. FREDERICK J. ROGERS. Ithaca, N. Y., Andrus & Church. 1897. Pp. vi. + 260.

Missouri Botanical Garden. EIGHTH ANNUAL REPORT. St. Louis, The Trustees. 1897. Pp. 236.